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OAK RIDGE NATIONAL LABORATORY

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Program Planning for Future Improvement in Managing ORNL's Radioactive Wastes

PREPARED BY

GILBERT/COMMONWEALTH
READING, PENNSYLVANIA
SEPTEMBER 1981

Under P O. No. 62B-13837C

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PROGRAM PLANNING FOR FUTURE IMPROVEMENT IN MANAGING ORNL'S RADIOACTIVE WASTES

NUCLEAR WASTE PROGRAMS

Operational Planning and Development
(Activity No. AR 05 10 05 K; ONL-WN06)

PREPARED FOR

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
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for the
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PREFACE

This report "Radioactive Waste Management, Improvement Planning" (GAI Report 2285) was prepared by Gilbert/Commonwealth (G/C) at Reading, Pennsylvania for the Operations Division of the Oak Ridge National Laboratory, Oak Ridge, Tennessee. The contributors to this report included:

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1.0 EXECUTIVE SUMMARY

The DOE Manual requires that for each DOE facility or site, a Radioactive Waste Management Plan be developed on an annually updated basis. In addition to detailing day-to-day waste management operations, this Plan must include a description of proposed or budgeted program improvement projects to be carried out over the subsequent five to ten years. The report presented here was prepared by Gilbert-Commonwealth to serve as a reference document and guide in developing the long-term improvements section of ORNL's radioactive waste management plan. The report reviews ORNL's operations and future program needs in terms of currently applicable DOE regulations and also in terms of regulations and accepted practices of the commercial sector of the nuclear power industry so that the impact of potential future adoption of these regulations and standards on ORNL's operations can be fully evaluated.

Development of this report involved a detailed review of all aspects of ORNL's liquid, solid, and gaseous radioactive waste management operations. Non-radioactive sanitary/hazardous waste management operations at ORNL and waste management operations at other UCC-ND sites in the Oak Ridge area were not reviewed and are only addressed in this report where they directly impact ORNL's radioactive waste management operations. In reviewing these operations, the major goals were to identify any existing or potential areas of concern, to identify areas where further R & D work or testing is needed to develop a satisfactory solution to the problem, and to develop preliminary cost and schedule information for the potential improvements to be made.

The evolution of this report has resulted in a document divided into four sections and four appendices. Section 1.0 is an introduction covering scope and major objectives, a summary of past and present practices, and a summary review of ORNL's last formal waste management improvements plan prepared in 1972. Section 2.0 is a summary of findings and recommendations in terms of general practices and specific improvement projects. Section 3.0 is a summary level schedule and program logic for carrying out recommended actions, and finally, Section 4.0 contains summary level cost estimates for each recommended improvement project. The four appendices provide supportive information for the recommendations made in Section 2.0. Appendix A contains summary descriptions of the waste generating, processing, and disposal activities at ORNL. Appendix B provides detailed discussion of the areas of concern summarized in the report, including the reasons and methodology for prioritizing these concerns, and detailed design, cost and scheduling information for the potential improvement projects. Appendix C gives definitions of terms and acroynms used in this report, and finally, Appendix D lists reference material used in generating this report.

The principal conclusion reached by Gilbert/Commonwealth after reviewing ORNL's waste management operations is that these operations are currently being conducted in a manner that does not endanger the health or safety of workers or the general public and that does not have an adverse effect on the environment. Although nineteen specific problem areas have been identified (as summarized in Section 2.0) all of these problems can be attributed to one of the following: a) the legacy of past practices; b) gradual deterioration of systems which have reached (or are near to reaching) the end of their reasonable design lives; and c) potential changes in regulations applicable to ORNL. As summarized in Section 3.0, all of the programs designed to improve or correct these problem areas could be accomplished within a four year period. However, given current limitations on manpower and capital, these programs would more likely be spread out over a five to ten year period of time if they were all to be undertaken. As summarized in Section 4.0, the cost of undertaking all of these projects concurrently is estimated to be between 60 and 100 million dollars. Due to the many unknowns and uncertainties associated with many of the problem areas, actual total costs for specific projects could be considerably different than those costs presented in Section 4.0. It is conservatively estimated that actual costs could vary from those presented in this report by as much as 300 percent.

Of the nineteen problem areas identified in Section 2.0, several are of particular importance from the standpoint of safety or overall impact on ORNL operations. Recommendations in these areas are summarized very briefly below:

1. Solid Waste Disposal - Although solid radioactive wastes produced by ORNL are presently being handled in a safe manner, continuing efforts are needed to find better ways of reducing and disposing of newly generated wastes to

minimize land usage and to further reduce the potential for the migration of radionuclides from these burial facilities into the environment. While it appears that the migration of radionuclides from "older," less conservatively buried wastes of the past has subsided (at least partially as a result of recent measures to halt the migration), continued and increased monitoring of these burial sites is needed for many years to insure that these conditions do not deteriorate. Unforeseen changes in regulations or site conditions could also lead to the future realization that even the conservative burial techniques being used today are not adequate enough. Factors such as these make solid waste disposal a most difficult and complex issue, with no easy or simple solutions to the problems involved.

Current plans for opening a new solid waste storage area in the late 1980's should incorporate burial/storage techniques that will permit better land utilization. Concurrently, studies should continue to find ways to further limit the amount of solid radwaste generated and to volume reduce those wastes once generated. Engineering/construction of an improved solid waste storage area is expected to take three years and $2,500,000. The Oak Ridge Solid Waste Disposal Facility, a centralized multi-plant facility in its final feasibility study phase, will, when completed, contribute significantly to solving the problems with ORNL's SRW to the extent of mitigating (and perhaps eliminating) the need for an ORNL improved solid waste storage area. A definitive study of current/future VR needs at ORNL would require six months and $200,000 to complete. Undefined capital projects may also result as an outcome of this VR study.

2. Liquid/Gaseous Waste Collection - The piping systems for collection of liquid low level waste, liquid intermediate level waste and gaseous wastes are all nearing the limit of reasonable design life. A conceptual design has already started for replacing the intermediate level waste collection system with two centrally located redundant collection tanks and new double walled 304 L stainless steel collection piping. The estimated cost of this project is $30,000,000. A complete evaluation of alternate, more corrosive resistant materials and alternate containment methods is needed before finalization of design for this improvement.

A complete survey and evaluation of the low level liquid waste system is needed to identify the necessary upgrading for this system. Such a study would take one year and $175,000 to complete. Follow-on repair or replacement would take two years and cost as much as $1,600,000. Before plans are made to replace either the LLW or ILW collection systems, the technical/economic feasibility of combining these collection systems should be carefully considered.

Engineering design is complete and work is beginning on a project to replace and upgrade the above-ground portions of the central gaseous waste collection system at Stack 3039. This project is expected to cost $6,700,000 and take 42 months to complete. Before completing engineering design for this project, a complete ALARA review of the proposed new system (as defined in Chapter 6.0 of the ORNL Health Physics Manual) should be conducted and a complete survey of the underground portions of the existing system should be made to determine the need for further replacement/upgrading. These studies would take six months and $150,000 to complete. Substantial additional capital improvement projects could be identified as a result of these studies.

The above projects for upgrading/replacing the individual liquid and gaseous waste collection systems are of substantial magnitude in cost and duration. Since these systems all service common areas of the laboratory complex, there is considerable merit to consolidating these replacement programs into one project. Such consolidation could reduce construction durations, reduce construction operation and maintenance costs by as much as 50 percent or more and could result in a more efficient overall radwaste system operations. A classification of monitoring systems and equipment according to specific application would be helpful. "Monitoring" the radiation level of a process - waste stream is considerably different than "monitoring" for radionuclides in a ground water level near a burial ground.

3. Process and Discharge Monitoring Equipment - Projects are underway to modernize the computerized data acquisition systems and to install new discharge monitoring weirs. The front-end radiation monitors must also be

upgraded to current industrial standards for more accurate measurement under various conditions. Thorough review of current conditions, specification of new equipment and identification of R & D needs will require about one year and approximately $200,000 to complete. Follow-up capital improvement projects could require up to 27 months and $1,250,000 to complete. Additional R & D projects of indeterminant cost and duration may also be necessary to develop more accurate instrumentation for monitoring discharges.

4. Design Documentation - Comprehensive system descriptions and process diagrams are needed in areas where these are now lacking. These and other design documents must be periodically updated as system modifications are made. An improved, computer assister filing/retrieval system is needed for this information. A dual record storage system is also required for protection against loss, fire, water damage, etc. These improvements are estimated to cost $500,000 initially and should be scheduled to compliment system modification projects now being planned or carried out.

5. Decontamination and Decommissioning - A large number of older facilities at ORNL are schedule for decontamination and decommissioning under DOE's Surplus Facilities Program at an estimated total cost of $40,000,000. These projects will have a major impact on all aspects of radwaste management operations. Detailed studies are needed to determine the radiological conditions in these facilities and the techniques required to process and dispose of wastes resulting from decontamination/decommissioning these facilities. It is estimated that these studies will take one year and $500,000 to complete.

1.1 INTRODUCTION

Chapter 0511 of the DOE Manual requires that each regional DOE office submit to headquarters an annually updated waste management plan for facilities or sites under each regional office's jurisdiction. The plan for each site must include planning and budgetary information for any proposed long-term (five year or longer) improvement programs or projects. Such a plan is now being developed by ORNL's waste management operations group as an update of previous long-term plans submitted to DOE (then AEC) in 1972. This plan will integrate all needed radwaste improvement activities and projects into a unified, systematic approach to facilitate assessment, selection and implementation, and will also serve as a tool for prioritizing and budgeting these needed improvements.

It is intended that the report presented here be utilized as a reference or source document in the development of ORNL's waste management plan. In order to serve in this capacity, this report presents an assessment of radioactive waste management operational practices at Oak Ridge National Laboratory (ORNL). It also identifies those action items that should be considered in developing the long range program plan for improving radwaste management operations over the next five to ten years. Toward this end, this document a) evaluates ORNL's current radwaste management facilities and practices from the standpoint of technology, safety, environmental effects and regulatory compliance issues, b) identifies where improvement planning emphasis should be placed in terms of upgrading facilities, equipment, operating practice and research and development needs, and c) suggests systematic approaches for accomplishing recommended improvements.

1.2 PROJECT SCOPE AND OBJECTIVES

The scope of this study represents a broad investigation of the radioactive waste management systems and operating practices utilized at the laboratory. For each of the major radwaste categories (solids, liquids, and gases) generation, collection, processing, storage, disposal, monitoring/control and general operating practices and procedures have been reviewed to achieve the following specific objectives.

- Assess the effectiveness of the present condition of ORNL radwaste systems for managing the different categories of radioactive wastes, and to identify and screen recommended improvements or corrections by considering general advantages/disadvantages, costs, R&D requirements, etc.

- Identify those practices which are at variance with current and anticipated regulatory requirements and accepted standards.

- Assess the relative seriousness of the identified concerns in terms of priority and difficulty of resolution.

- Develop broad estimates of the costs and schedules required for resolution of the identified concerns.

- Assess advanced technologies for applicability to ORNL radioactive waste management efforts.

- Identify areas requiring additional in-depth investigation and/or research and development effort.

- Develop a systematic implementation approach to serve as a guide for coordinating and accomplishing desired improvements.

In general, this study is limited to the radwaste management activities of the Operation Division of ORNL, X-10 site. Other Oak Ridge Sites (i.e., Y-12, K-25) as well as off-site practices (e.g., transportation) are not directly assessed; however, interface activities and mutual solutions to common problematic concerns are considered. Decontamination and decommissioning (D&D) program efforts have been factored into the improvement planning process. However, the specific impact of these projects on future operations has not been evaluated since these projects are in the early planning stages and detailed information is limited or not available at this time.

1.3 RADWASTE MANAGEMENT PRACTICES

1.3.1 Objectives of Waste Management Operations

Since its beginning in 1943, ORNL has generated large amounts of solid, liquid and gaseous radioactive waste material as a by-product of the basic research and development work carried out at the laboratory. The primary functions of waste management operations have been (and will continue to be): a) to collect, process and store or dispose of these wastes in a manner that will have minimal effect on the environment while ensuring that the health and safety of both workers and the general public are protected; and, b) to provide surveillance of the ORNL radioactive waste disposal systems to assure that they pose no unacceptable risk to the public or the environment.

In keeping with ORNL's basic charter to discover and develop new energy related technologies for both commercial and governmental applications, secondary functions of waste management operations have been to develop technological improvements for processing, containing, stabilizing and isolating radioactive wastes and to test the effectiveness of such new technologies by putting them into practice at ORNL. Meeting these secondary objectives has involved the waste management operations organization in numerous projects, ranging from laboratory and small-scale prototype testing to full-scale demonstrations, using the laboratory's own wastes as feedstock.

1.3.2 Past Practices

Past ORNL waste management practices have been in keeping with the rules, regulations and policies set forth in the DOE Manual regarding processing and disposal of radioactive waste materials. In a few instances where these general requirements would not be appropriate or practical to follow, ORNL and DOE have mutually agreed on modifications in the procedures, provided these modifications would not compromise the objectives stated above regarding protection of the environment and the health and safety of both workers and the general public.

In keeping with national policy, shallow land burial has historically been the standard method for disposal of low-level waste at ORNL. For higher activity low level waste, the standard method of disposal since the late 1960's has been hydrofracturing. For disposal of all types of level wastes (solid, liquid, and gaseous), full advantage has been taken of the fact that the laboratory is surrounded by a large exclusion area, which serves as both a natural barrier to the transport of radionuclides to the environment outside the reservation and as a mechanism for diluting the concentration of any nuclides that do eventually reach the reservation's boundary.

Another important, long-standing practice has been to minimize the impact of waste management operations on the basic R&D function of the laboratory. In general, radioactive wastes have been handled with as little restriction as possible being placed on both the quantities and physical/chemical makeup of the wastes generates as a result of the basic research work carried on at the laboratory.

1.3.3 Current Practices

In line with national policy, a formalized, long-term waste management strategy is being developed. This plan will ensure compliance with all state and Federal environmental protection laws that are applicable to ORNL's waste management operations. However, with regard to NRC regulations, while ORNL recognizes the need to be aware of areas in which these regulations are more restrictive than its own, it is ORNL's intention to continue to recognize the DOE Manual as the governing document for regulation of waste management operations.

With regard to land usage practices for waste storage/disposal, the present practice is to continue using ORNL's established storage/disposal techniques, but to reduce the impact these have on the environment as much as technically possible, keeping in mind the restraints of current economic realities. In line with this, steps such as increased emphasis on volume reduction are being taken to minimize contamination of the environment surrounding ORNL.

The waste management operations group has also continued a practice of minimizing the impact its operations have on the activities of the other divisions at ORNL. However, because of the many new restrictions being placed on the management of radioactive wastes (increased volume reduction, reduced discharges, long-term D&D impact, etc.) and because of the added costs resulting from the efforts to meet these requirements, it is now recognized that the front end of the radioactive waste cycle (i.e., the waste generator) must be focused on more closely, with the objective being to make necessary improvements in the waste generation practices wherever this can be done without adversely affecting the associated R&D activity.

1.3.4 Future Practices

Certain practices now being used at ORNL have been judged to be quite satisfactory in meeting all present and expected future regulations in a safe and economical fashion. Where this is the case, it is expected that ORNL would continue to follow these practices in the future. Where future changes in regulations, national policy, etc., are expected that would cause ORNL's current practices to become unsatisfactory, it would be expected that within a reasonable period of time, ORNL's practices would be updated to meet these new requirements. Several such areas in which ORNL should consider a general redirection of its practices in the future are given in Section 2.2.

1.4 PREVIOUS IMPROVEMENT STUDIES - CURRENT STUDIES

Prior to the current project to develop a comprehensive, long term plan for management of ORNL'S radioactive wastes, there have been a number of studies done to improve and upgrade various portions of the waste management operations. Collectively, these past studies could be considered as an informal waste management plan, and in many instances, they have been useful as a starting point in developing portions of the more formal plan presented herein. In most cases, these studies are referred to and/or discussed in relevant sections of this report. The one exception to this is the radwaste management review and upgrade study conducted in 1971 by a panel of experts from various divisions of ORNL. The final report of this committee, often referred to as the "Burch Report," contains an indepth review of all waste management operations as they were practiced in the early 1970's and lists numerous recommendations for either immediate action or long-term improvement. Because of the comprehensive nature of the Burch Report and its value as a basic building block for the present waste management planning effort, it was decided that a summary update of the Burch Report would be an appropriate lead into the present report to give the reader a clearer understanding of how and why ORNL's waste management program is where it is today, and where and why there is a need to change direction in the future. The following is a brief summary of the Burch Report as it relates to the current planning effort.

As presented below, the discussion under each "Finding" represents a condensation of the findings and recommendations of the Burch Report. The discussion under "Present Status" summarizes the efforts made to date by ORNL to comply with the recommendations of the Burch Report or gives reasons why these recommendations have not been followed.

1.4.1 Regulatory Compliance

a. Finding - All waste should ideally be reduced to completely innocuous form before release, or should be recycled for reuse, or should be permanently stored. This is a long term goal not immediately achievable. It must also be kept in mind that imperfect storage can also give rise to effluents that must be controlled to prevent harmful effects.

Present Status - Intermediate level waste (ILW) waste is now stored until safely disposed of via hydrofracture. A new process system Scavenging Precipitation - Ion Exchange Process (SPIX) has been developed to minimize low level waste (LLW) releases. As yet, there has not been a concerted effort made to recycle wastes.

b. Finding - A single release point must be established for liquid effluents and must be acceptable to all regulatory bodies. The outfall of White Oak Dam is recommended as this point, although it is recognized that one day even credit for dilution in White Oak Creek may not be acceptable.

Present Status - The outfall of White Oak Dam has become the accepted site discharge point. There is greater awareness and acceptance of the possibility that fuller compliance with ALARA will eventually require giving up White Oak Lake as a buffer zone.

c. Finding - ORNL must develop a formal "Waste Management Plan". As part of this plan, the division of responsibility between various organizations in reporting releases must be formalized. Too many groups are involved in reporting and regulating portions of the total release on an informal basis.

Present Status - A formal plan has not yet been developed, although the responsibilities for waste management have been centralized into one group having broad authority in controlling all areas of waste handling/ disposal and directing future waste management improvements.

d. Finding - One group should be assigned the responsibility of maintaining up-to-date files on all environmental regulations.

Present Status - This responsibility has been assigned to the Department of Environmental Management.

e. Finding - New environmental regulations being developed by various agencies are too uncertain. Therefore, ORNL should adopt a "wait-and-see" attitude.

Present Status - Although environmental regulations have stabilized, jurisdiction over DOE sites is still not completely settled. Thus, ORNL is continuing a "wait-and-see" attitude.

f. Finding - AEC's interpretation of "as low as practicable" would impose a 5 Curie/year limit on commercial power reactors. "ALAP" has not been incorporated into the AEC Manual, but one day, these limits (or some agreed-upon compromise) may be imposed on ORNL.

Present Status - ALARA is now a part of the waste management philosophy in the DOE Manual. However, quantitative ALARA release limits have still not been set.

g. Findings - The proposed Chapter 0511 of the AEC Manual was expected to impose the following:

- Long-term tank storage of High Level Waste (HLW) will not be acceptable beyond five years.

- Waste designated for long-term storage will have to be solidified. Storage method must not preclude later removal of waste from storage. Hopefully, hydrofracturing will be judged a satisfactory "storage" method.

- Transuranic (TRU waste must be segregated in retrievable storage form.

- Essentially, the newly required "Waste Management Plan" will consist of a system description and Final Safety Analysis Report (FSAR.)

Present Status - Chapter 0511 is now a part of the DOE Manual. Actual requirements related to the above findings are:

- HLW can be stored for longer than five years, if adequate containment systems are provided.

- o Solidification is not mandatory for long-term storage and interim approval has been given to consider hydrofracturing as a "storage" method. However, the practicality of retrieval, once emplaced, must still be questioned.

- o ORNL now segregates TRU waste for retrievable storage.

- o System descriptions and SAR's have been written for the various radwaste processing systems. However, the Waste Management Plan must also look ahead at least five years to include planning and budgeting for future improvements.

1.4.2 Solid Waste Disposal

a. Finding - Present practices meet all applicable regulations and should be continued with modest improvements for the immediate future.

Present Status - Continuation of practice with modest improvements.

b. Finding - Establish procedures for regular surveillance/examination of retrievable TRU.

Present Status - Such procedures have been adopted. These have already proven useful in spotting and correcting problems.

c. Finding - Centralized facility for incineration, compaction and packaging of all Solid Radioactive Waste (SRW) should be a top priority. A conceptual study is needed and should consider use of existing buildings (3505, 3517, etc.) and inclusion of radioactive waste from other UCC-ND sites. The need for this is justified by loss of land resulting from present processing/disposal methods, higher costs for opening a new shallow land burial facility in the future, and the desirability of having ORNL, as a major AEC-operated facility, practice exemplary SRW processing/disposal methods.

Present Status - A compaction facility has been estabilshed. An incineration facility is still only in the preconceptual stage, and for budgetary reasons, may not go beyond this stage.

d. Finding - Development and pilot plant testing of ORNL's Pressurized Aqueous Combustion and Pressurized Oxygen Incineration processes should be accelerated. Semi-conventional incineration of low-level waste should be pursued.

Present Status - Technical problems related to safety were experienced with both of these projects and both have since been discontinued. Various other incineration plans have been considered but not pursued for technical or economic reasons. ORNL is now practicing a "wait-and-see" approach until an acceptable technology has been developed by others.

e. Finding - Construct a component decontamination facility.

Present Status - A decontamination facility has been set up in Building 3517. A project is currently under way to add an electropolisher to this facility.

1.4.3 Liquid Radioactive Waste Disposal

a. Finding - Hydrofracturing should be retained as the permanent method for disposing of all Liquid Radioactive Waste (LRW) on the basis of cost, safety and AEC policy favoring on-site disposal if practical.

Present Status A new, permanent hydrofracture facility is nearing completion and awaiting final go-ahead from DOE to begin operation.

b. Finding - HLW & TRU waste should be hydrofractured after holdup for decay (if necessary) and dilution with ILW waste to less than 5.3 Ci/liter (beta). Tank sludge and small amounts of organic liquids (< 4000 liter/yr) should also be hydrofractured.

Present Status - Some TRU waste has been disposed of in the interim hydrofracture facility. No HLW has been disposed of in this manner, but the design of the new hydrofracture facility has allowed for this and the SAR for the facility proposes that this be permitted. Testing has been done to show that waste containing one percent or less of oil can be hydrofractured successfully. A program is now underway to demonstrate the compatibility of gunite tank sludge with hydrofracturing.

c. Finding - If hydrofracturing is not licensed by the AEC, a recommended alternative would be to dry the sludges, shipping the sludge to an off-site repository and hydrofracture the supernatant.

Present Status - This concept was developed in the Environmental Impact Statement for the ILW Disposal System, but was eliminated from serious consideration on the basis of cost and safety.

d. Finding - Sludge from the LLW lime-soda operation should continue to be disposed of in open pits until the new processing system is emplaced. After that, the sludge should be hydrofractured or disposed of in lined pits.

Present Status - The new SPIX process no longer produces sludge.

1.4.4 ILW Collection/Treatment

a. Finding - To insure that the ILW system will continue to be able to handle waste inputs adequately, it may one day be necessary to evaluate the procedures and practices of individual waste generators more closely with the objective of decreasing the volumes of waste generated.

Present Status - To date, the Waste Management Operations Group has been able to meet all new and more restrictive waste handling/disposal regulations by modifying the radwaste systems rather than by restricting the research programs of the waste generators.

b. Finding - Per AEC directive, the gunite tanks must be deconned and decommissioned. To accommodate this, the following ILW system changes should be made:

- o Add two doubly contained 950,000 liter concentrate storage tanks at the new hydrofracture facility. All new SS pipeline to service these tanks - either double-walled or in concrete chase.

- o Add two doubly contained evaporator surge tanks - one at 380,000 liter capacity and the other one at 190,000 liter capacity.

- o Leave gunite tanks in place for emergency use.

- o While gunite tanks are still being used, monitor flow and activity in groundwater under them.

- o Permanently install the spare ILW evaporator.

Present Status - To date, the following modifications have been made:

- o Eight new 190,000 liter tanks have been installed at the new hydrofracture facility and an underground, double-walled SS transfer line has been installed between them and the evaporator facility.

- o Three 190,000 liter evaporator feed/concentrate tanks have been installed and double-walled piping has been put in between them and the collection tanks.

- o The gunite tanks are now being deconned and decommissioned.

- o The spare evaporator has been permanently installed.

c. Finding - A new 38,000 liter doubly contained tank is needed in Melton Valley for separate collection of higher activity TRU/TURF wastes.

Present Status - This tank and an underground, cathodically protected transfer line to the evaporator facility have been installed.

d. Finding - Make minor modifications to the ILW evaporator to improve DF, reduce foaming, increase reliability and achieve higher boilup rates.

Present Status - All of the Burch Report recommendation regarding the ILW evaporator have been implemented. The unit is now operating satisfactorily.

e. Finding - Several intermediate holdup tanks have been found to be leaking, but most appear to be in reasonably good shape. Those no longer in use should be drained and left intact. It is not economically feasible at present to replace the others with double-contained tanks.

Present Status - A project is now in the conceptual design phase to replace all Bethel Valley intermediate holdup tanks with two redundant, doubly-contained tanks.

f. Finding - Gravity drains from the waste generators to the intermediate holdup tanks may be in poor conditions. Since they are not under pressure and since most contain lower activity wastes, no major hazard is perceived, and no upgrade or testing is recommended at this time.

Present Status - As part of the tank replacement project, it is now proposed that all of these lines be replaced with doubly-contained piping back to the source generator buildings.

g. Finding - Pressurized lines from the intermediate holdup tanks to the ILW collection tanks that contain more than 25 mCi/liter should be equipped with isolation valves for hydrotesting.

Present Status - As part of the tank replacement project, it is now proposed that all of these lines be replaced with doubly-contained piping that would have provisions for leak testing.

h. Finding - The ILW system should continue to be used to handle small amounts of radioactive organic solutions.

Present Status - Written procedures now permit processing of a limited amount of organic solutions.

1.4.5 LLW Collection/Treatment

a. Finding - A new processing system with the capability of reducing Sr-90 releases by at least a factor of 100 should be installed immediately to reduce the concentration in the site discharge to less than MPC. Reduction to some lowest practicable level, yet unspecified, is a future long-range goal.

Present Status - A new process system (SPIX) was installed in 1975. As a result, site releases are now well below MPC levels. Long-range reduction goals have not been finalized.

b. Finding - Chronic seepage of contaminated ground water around Building 3525 into the sewage system should be diverted to the LLW system.

Present Status - Several unsuccessful attempts at correcting this problem have been made. There are currently no plans to try other corrective measures.

c. Finding - Seepage of contamination into the Fifth St. branch of White Oak Creek should be corrected.

Present Status - This problem is still under study. The problem area appears to be centered under Bldg. 3047.

d. Finding - A large portion (75 percent) of the activity entering the LLW system is a result of groundwater inleakage into drain lines south of Building 3047. Situation should be studied by competent hydrologist to determine best course of action.

Present Status - Situation is still unresolved. This inleakage now accounts for about 30 percent of total activity input.

e. Finding - Interconnections between the ILW and LLW systems via valve pit sumps, etc provide pathways for significant injection of activity into the LLW system. A thorough study of this should be done to identify where these cross-ties should be eliminated.

Present Status - Most of these interconnects are dormant and would require deliberate operator action to divert ILW to the LLW system. Furthermore, current plans to replace all intermediate holdup tanks with two centrally located tanks would eliminate this problem altogether.

f. Finding - In 1971, a large percentage of the Sr-90 reaching the Clinch River (40 percent) was attributed to the Solid Waste Storage Area (SWSA's) in Melton Valley. Indications are that this is increasing. A thorough study of the geology and hydrology of the area is needed to determine proper corrective actions.

Present Status - Numerous studies and monitoring programs have been conducted. Numerous corrective measures have also been undertaken (grading, capping, etc.). Since reaching a peak in 1974, total site releases have steadily declined and are now at or below 1971 release levels.

g. Finding - The settling basin (3513) should be filled and capped. The equalization basin should be dredged and a membrane liner applied.

Present Status - It is planned to Decontaminate and Decommission (D&D) the settling basin as soon as several current biological research programs centered around this basin are completed. There are no current plans to modify the equalization basin.

h. Finding - Recycling of waste water may be a necessity in the future if the needs of ORNL and the city become great enough to overload current makeup capacity. The new LLW process treatment system may provide water of sufficient quality for this purpose.

Present Status - As yet, there has not been a formal study made of the feasibility of recycling process water for reuse.

1.4.6 Radioactive Gaseous Waste Systems

a. Finding - Emergency power supply for standby cell ventilation fans and steam-powered standby fans are not adequate. The capacity and reliability should be increased.

Present Status - As part of a general upgrade of the ventilation system at the base of Stack 3039, these concerns have been addressed.

b. Finding - Present equipment for measuring and monitoring stack releases are adequate, but dual inventory samples should be routinely taken where possible for substantiating sample accuracy. The equipment should be kept in full effect and maintained on a continuous basis.

Present Status - Dual sampling is provided at Stack 3039 and it appears that the equipment is being fully maintained.

c. Finding - Fire barriers should be added to selected systems to improve the isolation of combustible components.

Present Status - Primarily due to economic constraints, these barriers have not been added to any buildings already in existance. Such barriers were designed into Building 7830 which was recently constructed.

2.0 SUMMARY AND CONCLUSIONS

2.1 GENERAL ASSESSMENT OF RADWASTE MANAGEMENT OPERATIONS

2.1.1 Summary

Radioactive waste management at ORNL is a major operation, requiring the talents of a large number of individuals from various disciplines to function properly. About three percent of the Laboratory's yearly operating budget is used to run the waste processing and disposal facilities. But indirectly, waste management operations are responsible for significant additional spending if the various radwaste monitoring programs, radwaste R & D projects and current radwaste system capital improvement projects are considered.

In terms of both activity and volume, large amounts of radwaste must be handled each year at ORNL. To put this in perspective, the amount of liquid and solid waste generated is roughly five times the amount produced by a typical 1000 MWe boiling water reactor power plant. Since the Laboratory was created in 1943, a rather large and complex network of interconnecting collection, processing and disposal facilities has evolved to handle these wastes. While there has been considerable upgrading of these facilities in recent years, portions of the existing systems are in need of additional repair, upgrading or replacement to meet current industry standards.

Given the large quantities of waste handled each year and the worn/ outdated condition of some portions of these facilities, the waste management operations group has had an excellent record in safely processing and disposing of these wastes. In all cases, the rules and regulations presently applicable to ORNL are being met in full. Both liquid and gaseous waste releases are far below allowable limits, and available information indicates that current solid waste disposal activities are releasing insignificant amounts of activity into the groundwater. While ORNL is now handling its wastes in an exemplary fashion, there are a number of areas where improvement is necessary or could become necessary as a result of continued deterioration of system, changing economic conditions, potential regulatory changes, etc. These improvements and the principal reasons for making them are summarized briefly in the following paragraphs.

2.1.2 Future Regulatory Compliance

It is anticipated that regulatory requirements for ORNL will become more restrictive in the future as a result of either direct or indirect involvement of the NRC and EPA in the regulatory process. Should this change in regulatory authority ever occur, major modifications could be required in many areas of ORNL's waste management operations as identified in appropriate sections of this report.

2.1.3 Solid Radwaste Management

Current solid waste management operations are being conducted in an exemplary fashion. All wastes are handled safely and in a cost effective manner. The legacy of inadequately buried wastes from past operations is still with ORNL, but various corrective measures appear to have had some degree of success in halting the spread of radionuclides into the environment from these buried wastes. There are also other measures which could be taken, although further testing is needed to ascertain the long-term effectiveness of these measures. As a final resort this waste could be exhumed for repackaging and reburial elsewhere, but considering the relatively minor impact the current conditions have on the environment, such costly and exposure intensive measures as these are not likely to be justifiable. In addition, the proposed new centralized solid waste disposal facility referred to earlier will mitigate future problems and perhaps eliminate the need for SWSA-7.

Although considerable effort is made to volume reduce (VR) solid wastes prior to disposal, further reductions could be achieved by adding more sophisticated VR equipment. However, given the current low costs for waste disposal at ORNL, such additions cannot be justified on an economic basis. Therefore, for the near term, any significant improvement in VR capability would have to be justified solely on the basis of satisfying DOE directives to minimize land usage for waste disposal purposes.

2.1.4 Liquid Radwaste Management

ORNL routinely handles relatively large amounts of liquid radwaste in terms of both volume and activity. For example, although ILW normally measures less than 10 μCi/cc, waste streams can be as high as 5000 μCi/cc. Putting this in perspective, the highest activity level in the sump water from TMI-2 after the accident there in March 1979 never exceeded 200 μCi/cc. Overall, ORNL's record in handling these highly radioactive liquids has been very good.

An extensive network of underground piping and tankage is provided to collect and store both LLW and ILW prior to processing and discharge. Together, the LLW and ILW collection systems contain nearly twenty miles of piping. Much of this piping is over thirty years old, and there is evidence of substantial loss of integrity or potential loss of integrity in both the piping and tankage. Although there is considerable groundwater contamination in the area around some portions of these collection subsystems, there is no evidence that any significant amount of this has reached the site boundaries. Nevertheless, substantial repair/replacement programs will be necessary for both of these collection systems in the near future.

In contrast to the collection systems, the LLW/ILW processing systems are relatively new and in good condition. Since startup of a new ion exchange process in 1976 and a new evaporator in 1979, ORNL's performance record in processing these wastes has been excellent. Typically, discharge concentrations of Sr-90 (the primary isotope of interest in most effluents) are below the maximum permissable concentration (MPC), and other isotopes are below one percent of MPC. One area where possible improvement is still needed is that of recycle capability for processed water.

Disposal of concentrates from the liquid waste processing systems is now being handled in an acceptable fashion that has little effect on the environment. However, should any problems develop with hydrofracturing, the lack of any backup system for handling ILW sludge would be a serious problem. While disposal of LLW sludge in lined, open pits represents little hazard, the redesign and modification of the process work treatment plant now in progress will eliminate the sludge.

2.1.5 Gaseous Radwaste Management

A significant portion of the older sections of the gaseous waste collection and treatment system has deteriorated to the point where the potential now exists for inefficient, ineffective and unsafe operation of this system. At present, the amount of activity handled and released by this system is well below MPC levels, thereby minimizing the hazards associated with these conditions. However, complete failure of this system under normal conditions or abnormally high releases from the source generators would pose a potentially hazard to workers and, to a lesser degree, to the general public and environment. Therefore, repair/replacement of all or major portions of this system is a high priority. Such a program has already been initiated for above-ground portions leading to the central dishcarge stack. Similar programs may be necessary for the other stacks and for the extensive network of underground piping and ductwork.

2.1.6 Discharge Monitoring/Control

An extensive system of monitors is now provided to measure and record liquid/gaseous releases from all normal discharge points. This network appears to provide adequate coverage for all normal releases; however, in many instances the monitoring instruments are of outmoded designs which are inaccurate or otherwise inadequate under certain conditions. A general upgrade of monitor design is needed.

Of additional concern is the monitoring and control of miscellaneous local discharge points. There are many release points, throughout the laboratory, many of which are not monitored or otherwise controlled. Most of these handle very little or no radioactivity and those that do are vented to the plant stack systems. However, verification and documentation of this fact is needed.

2.1.7 General Radwaste Management Operations

In general, the radwaste management operations group is well organized and responsive to the needs of the Laboratory in handling waste by-products from the numerous R & D and pilot plant projects being carried out. However, in several areas there is some room for improvement to more fully satisfy anticipated future needs and regulatory constraints. These include:

- Formal, long-term facilities consolidation planning.

- Formal planning of D & D projects, with greater involvement of the radwaste management operations group in developing D & D policy/plans.

- Formal interfacing with the radwaste generators, with the possibility that in the future the radwaste management operations group will have to exercise some control over what each generator produces.

- Formal documentation of system design and operation. Greater emphasis is needed on incorporating formalized "configuration management" techniques, not only in the design of add-ons or modifications to the present systems, but also in documenting what has been constructed in the past. The importance of such documentation cannot be over-stated in terms of its usefulness in conducting future design reviews/design verification and in planning future system modification.

- Formal ALARA reviews of system designs and operation. Documented reviews are needed for initial design. Periodically, they are also needed to verify that ALARA principles are being complied with by operations and maintenance personnel.

2.2 GENERAL RECOMMENDATIONS REGARDING FUTURE PRACTICES

ORNL's waste management operations have had an excellent record with regard to protecting the health and safety of workers and the general public. These operations have also had minimal adverse effects on the environment. Based on this record, any immediate departure from the present practices described in Section 1.2 is not warranted or recommended. However, in several areas, a gradual shift to what might be generally classified as a more defensive or conservative practice should be considered. These practice recommendations are discussed below:

2.2.1 Adoption of Practices Consistent with Optimized Land-use and Recovery of Resources

In future planning, greater emphasis should be given to developing and implementing ways of reducing the amount of radioactive waste generated. One administrative means of doing this is to move the responsibility for management and control of the amount of radioactive waste generated closer to the source of the waste. This should help to minimize the amount of radioactive waste generated, as well as give a better characterization of the waste which is generated. Other ways are to perform R&D and develop pilot plant projects that will identify effective ways of achieving this goal.

Greater use should be made of waste processing techniques and waste management procedures that emphasize resource recovery. Recycling of waste water and decontamination/reuse of equipment are examples of practices that will conserve valuable resources by reducing the need for replacing equipment/materials, by reducing consumption of water, and by reducing the usage of land area.

Separation between facilities or duplication of facilities and/or operations can be wasteful of many resources, among these being land, consumable materials and human resources (man-power and man-rems). After considering all trade-offs and technical/economic limitations that may be involved, steps should be taken, where ever practical, towards greater consolidation of waste management facilities and operations within ORNL itself and in conjunction with other UCC-ND sites. Prime examples of areas where such consolidation should be considered and co-operative efforts to construct a centralized incineration facility or to establish a common burial ground for low-level wastes.

Emphasis is also needed on D&D projects and other activities that are geared to restoring contaminated facilities and land areas to conditions that will allow them to be recovered for other uses. Above all else, all necessary steps must be taken to prevent conditions from deteriorating to the point where there is a serious health threat to future generations utilizing the facilities or surrounding land areas. In line with this, facilities now classified by DOE as surplus should, be decontaminated and reused, dismantled and disposed of or entombed, in that order of preference, as advanced by DOE. For each facility, the method should be carefully selected on a case-by-case basis, considering all factors, including DOE policy D&D activities should also favor long-term resource recovery objectives rather than short-term goals when these are in conflict. For example, an interim solution to leaching from open ILW sludge disposal pits may be to seal and cap these pits. A more permanent solution is to remove this sludge, reduce its volume, and dispose of or store the product retrievably, keeping in mind that storing the product retrievably creates a new set of problems which may be as severe as the one being solved.

Finally, more intensive efforts should be made to minimize land usage by installing additional volume reduction capability. The objective should be to eventually reach the maximum degree of volume reduction technically/economically feasibile for each type of waste anticipated. For instance, all combustible waste might eventually be incinerated, all wet wastes may be taken to total dryness, and all metallic material might either be melted down or reduced by special incineration techniques such as slagging pyrolysis.

2.2.2 Adoption of More Restrictive NRC/EPA Criteria for Radioactive Waste Management

By federal law, NRC and EPA do not have jurisdiction over the management of radioactive wastes at DOE sites. DOE is a self-regulating agency in this area and over the past thirty years has developed rules and regulations for handling radioactive wastes that parallel those now governing commercial industry, but which are, in certain respects, perceived to be less conservative. While NRC/EPA regulation of DOE waste management activities may never come to pass, the policy should be that wherever there is justification for a more restrictive practice, then this practice should be adopted, if careful consideration of all other factors involved shows this to be a reasonable course of action to take. Therefore, as a general, long-term objective, efforts should be continued to bring ORNL waste management activities in line with more restrictive NRC/EPA criteria, where justified. In areas where the converse is true (as may be the situation in the case of ORNL's handling of intermediate level waste), ORNL should, as its charter requires, strive to provide the commercial sector and regulators of the commercial sector with the guidance needed to upgrade commercial practices and regulations to be comparable with those followed by ORNL.

2.2.3 Demonstration of Improved Waste Management Practices

To meet the technical and economic challenges created by new, more restrictive regulations governing the processing, transportation and disposal of radioactive wastes, innovative new waste management process techniques and practices are needed. To support the needs of both ORNL and the national Low-Level Waste Management Program in these areas, ORNL should aggressively pursue government funding for R&D programs to develop and test promising new concepts in a timely manner.

2.2.4 Utilization of Total Systems Approach to Future Improvement Projects

This report identifies a number of areas where major capital improvement projects are needed to upgrade ORNL's waste management operations. In the past, funding restrictions or other considerations have resulted in such projects being conducted somewhat independently of each other, and in some cases this has led to unnecessary additional costs, unnecessary duplication and less efficient overall operation. In carrying out future improvements projects, it is important to the overall, long-term success of the improvements program that a total systems engineering approach be used to design and construct these projects, as outlined in UCC-ND Engineering Procedure EP-A-25. As much as possible the inter-relationships and inter-dependencies between these projects must be fully identified and considered before finalizing the design of any one project in order to avoid incompatibilities in the end products or unnecessary and wasteful duplications. Excellent examples of where this philosophy should be applied are: a) the various projects underway to upgrade various portions of the front-end monitoring equipment and the downstream data processing systems; and b) planned or proposed projects for upgrading the LLW, ILW, hot off-gas and cell ventilation collection networks in commonly shared areas of the site.

2.2.5 Adoption of Uniform Waste Categorization/Disposal Practices

Within the nuclear industry, there is a disturbing lack of consistency from one organization to another in defining categories of waste and identifying the hazards associated with each of them. Consequently, there is disagreement and some degree of inconsistency among both waste generators and regulators concerning the level of safeguards perceived as being necessary in setting intermediate handling and ultimate disposal requirements for particular waste types. Ever increasing emphasis on volume reduction before disposal will only worsen this situation due to the fact that volume reduction of low level waste will lessen the gap in activity levels between these wastes and high level wastes.

In order to strengthen both the safety and credibility of the national programs for disposal of all forms of radioactive waste (high, low or other), it is mandatory that these differences be resolved so that a truly uniform national policy can be developed. Through its own waste management practices and through its lead role in working groups assigned to setting national waste management policies, ORNL should strive towards developing more uniform, workable standards for characterizing waste types and the hazards associated with them.

2.3 SUMMARY OF RECOMMENDED IMPROVEMENT PROJECTS

One of the major objectives of this project was to conduct a through review of ORNL's existing radwaste management facilities to determine what specific corrective measures would be necessary to bring ORNL's operations in line with regulations currently applicable to ORNL and also to determine what specific improvements should be made to either satisfy potential changes in regulations or to bring ORNL's operations in line with commercial nuclear industry practices and regulations. In carrying out this objective, five basic categories of waste management were selected for review. These were: a) solid radwaste; b) liquid radwaste; c) gaseous radwaste; d) discharge monitoring and control; and e) general waste management operations. As shown in Figure 2.3-1, several of these princpal categories were further subdivided into two or more sub-categories to facilitate the review process.

For each waste management category or subcategory, a systematic review was carried out that involved consideration of six functional activity categories. The activities considered were: a) generation; b) collection; c) processing; d) storage; e) disposal; and f) miscellaneous other (administration, general planning, etc.). Where not applicable to the particular waste management category being reviewed, certain of these activities were not considered.

To provide a data base for this review, both site field trips and reference documents were relied upon. Numerous trips were taken to inspect various portions of the present systems. A voluminous number of system descriptions, safety analysis reports, operating records/reports, conceptual design studies, and R&D project reports were also reviewed in detail where additional information or insight into a particular area were needed. The supporting documentation used for this purpose is tabulated in the reference list appended to this report.

Generally speaking, the decision on whether or not a problem exists in a specific area of ORNL's waste management operations was based on consideration of the following criteria:

a. The impact on the health and safety of workers or the general public (real or potential).

b. The effect the situation has on the environment (real or potential).

c. Failure to meet currently applicable values and regulations.

d. Inability to meet expected or potential future rules and regulations.

e. Nonconformance with generally accepted industry practices/policies (especially ALARA practices/policies).

f. Cost inefficiencies in facilities design and/or operations.

As a result of this entire review process, nineteen areas were identified in which some form of improvement is recommended. Table 2.3-1 provides a brief description of each problem area and a summary of the action (or actions) recommended to effect improvements to the current situation. In Table 2.3-1, the problem areas are arranged according to the waste management category with which they are most closely associated. This same order and method of presentation is used in Appendix B where the individual areas of concern and recommended actions are discussed in much greater detail. For reader convenience, Table 2.3-1 provides a cross-reference to the appropriate subsections in Appendix B where more in-depth information can be found.

For each area of concern identified in this study, Table 2.3-1 also summarizes the priority level that should be assigned to dealing with it. Priority levels were assigned in accordance with the general criteria presented in Section 2.0 of Appendix B and which are further expanded upon for each problem area in Section 3.0 of Appendix B. To aid in understanding where resolution of each problem area would fit into an overall improvement program on a priority basis, a summary of these problem areas by priority level is given in Table 2.3-2. In using these priority level ratings, it should be kept in mind that they apply to the problem area itself and <u>not</u> the recommended solutions. In many cases, the recommended solution consists of a number of recommeded actions which may need to be done in series and or parallel with other actions. Proceeding from one action to the next may depend on the outcome of recommended studies, the availability of manpower and funds, etc. Considering these complex interactions and the many unknowns involved, it would not be possible at this point to put a priority level on each individual action involved in correcting or improving a particular problem area.

Table 2.3-1 also presents summary cost and schedule information for each recommended improvement project where it is possible to determine such information. More detailed schedule and cost data are provided in Sections 3.0 and 4.0. All data on project costs should be treated with reservations so indicated below. In summary, the duration of each improvement project ranges from only a few month to as much as four years. Whether or not these projects can be run in parallel depends on many factors beyond the scope of this study (available funds and manpower, etc.). Where the start of a project is constrained by completion of another project or availability of certain data, note is made of the fact in the summary Milestone Schedule presented in Figure 3.3-1.

The cost information presented in this study is, for the most part, very preliminary in nature and should not be used for anything other than budgetary purposes (i.e., selection of alternatives or other engineering decisions should not be based on these figures). Improvement project costs vary greatly, ranging from tens-of-thousands of dollars for a few small study efforts to as much as $30 million for replacement of the ILW collection system. If all improvement projects recommended by this study were approved and implemented, the total cost would be in the range of $75 to $100 million dollars.

The cost data presented in this study are order-of-magnitude estimate that provide a basis for comparing the magnitude of projects. Therefore, the data are useful for planning and discussion, but due to their preliminary nature they should not be used for budgetary purposes or as a basis for engineering decisions, such as the selection of alternative courses of action.

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (1)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Current Conditions: Priority Level	Recommendations: Summary Description	Recommendations: Estimated Project Duration	Recommendations: Type of Funding	Recommendations: Estimated Funding Level
3.1.1	LOW-LEVEL SRW Processing/ Disposal	1. Radionuclides leaching from existing burial grounds may not be within ALARA guidelines. Resultant contamination of land areas not in accordance with DOE policy. Use of present burial practices in future SWSA's do not meet proposed NRC/EPA criteria. Problems with future waste disposal will be magnified by lack of ultimate VR capability, site geology/ hydrology characteristics and large quantities of future D&D wastes.	III (for existing SWSA's) I (for future SWSA's)	1.a For existing SWSA's continue investigations of extent of radionuclide migration and effectiveness of various leachate control measures.	To be determined	Operating	Continue at spending level of $500,000 to $1,000,000 per year
				1.b. Proceed with current plans for expanding groundwater monitoring program for existing burial grounds.	6 mths (to install wells)	Operating	$50,000 (to install wells)
				1.c On case by case basis, exhume wastes in burial trenches/pits where deemed necessary by results of monitoring program in Item 1.b	6 months (for planning study)		$100,000 (for preliminary planning study)
				1.d Proceed with planning for SWSA-7. Incorporate hybrid disposal methods in design.	3 yrs (design & site selection)	Capital	1.0 million (design & site selection)
				1.e Conduct detailed VR study to identify means of further reducing significant volumes of SRW by segregation, modifying operating procedures and installing low-budget VR equipment, making use of existing surplus facilities where possible.	6 mnths	Operating	$150,000
				1.f Proceed with joint venture to construct hazardous waste/ radioactive LLW incinerator for shared use by all UCC-ND sites.	3 yrs (design & construct)	Capital	$10 to 15 million
				1.g Proceed with conceptual design and construction of the Oak Ridge Solid Waste Disposal Facility. Such a facility might eliminate the need for 1.d and mitigate the needs of 1.e.	Uncertain	Capital	$13,300,000(2)

NOTE: (1) Cost estimate for projects and recommended actions are very preliminary and should not be used for budgetary purposes.

(2) The total costs for this centralized facility could change significantly from this estimate since the facility will be constructed in stages over a period of years.

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Current Conditions: Priority Level	Recommendations: Summary Description	Recommendations: Estimated Project Duration	Recommendations: Type of Funding	Recommendations: Estimated Funding Level
3.2.1	LIQUID LLW-Collection	2. Underground collection system piping no longer leak tight. Inadequate means to test for (or measure) in-leakage/out-leakage. In-leakage increases load on process equipment and operating costs. Out-leakage is uncontrolled/unmonitored release that may not be ALARA.	III	2.a Gather complete, up-dated engineering data (routing, pipe inverts, etc.). Field measure as required.	6 mths	Operating	$50,000
				2.b Install temporary/permanent flow monitors and perform water balance.	9 mths	Capital	$100,000
				2.c Assess radiological impact. Evaluate cost/benefit of alternate repair/replacement options.	2 mths	Operating	$25,000
				2.d Implement best-evaluated corrective measure if justified by cost/benefit study.	8 to 24 mths	Capital	$150,000 to $1.6 million
3.2.2	LIQUID LLW-Processing	3. Process waste basins/ponds are open/unlined. Resultant uncontrolled/unmonitored release of radionuclides may not be ALARA. Collected precipitation increases load on processing equipment and operating costs.	III	3.a Gather complete, up-dated engineering data (construction details, inverts, radionuclide inventory, etc.).	3 mths	Operating	$25,000
				3.b Monitor surrounding environment to quantify pathway releases.	12 mths	Operating	$150,000
				3.c Assess radiological impact. Evaluate cost/benefit of alternate corrective measures (lining/covering or closed tanks.	2 mths	Operating	$25,000
				3.d Implement best evaluated alternative if justified by cost/benefit analysis.	10 to 18 mths	Capital	$350,000
3.2.3	LIQUID LLW-Sludge Disposal	4. Use of open pits for sludge disposal may not be ALARA because of groundwater contamination/intrustion potential. DOE Manual requires phasing out of this practice.	I	4.a For each open settling pond or pit, gather data on isotopic content and monitor groundwater around perimeter.	6 mths	Operating	$150,000

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

		Current Conditions		Recommendations			
Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Summary Description	Priority Level	Summary Description	Estimated Project Duration	Type of Funding	Estimated Funding Level
				4.b Evaluate need to exhume sludge from pits/ponds versus capping/sealing.	Included in 4.a	Included in 4.a	Included in 4.a
				4.c Proceed with corrective measures selected in Item 4.b.	1 to 3 mths per pond	Capital	$35,000 to $750,000 per pond
				4.d Evaluate alternate means of disposing of future LLW sludges.	6 mths	Capital	$100,000
				4.e Proceed with best evaluated alternate sludge disposal method.	2 yrs or less (dependent on Item 4.d)	Capital	$750,000 or less (dependent on Item 4.d)
3.2.4	LIQUID LLW-Contaminated Oil Disposal	5. No available disposal method for oil. Continued storage increases fire hazard and resultant uncontrolled activity release.	II	5.a Continue storage on interim basis until hydrofracture facility or incinerator is available.	NA	NA	NA
				5.b Dispose of in hydrofracture facility or centralized waste incineration facility when available.	NA	Operating	$10,000
3.2.5	LIQUID LLW-Discharge/Recycle	6. Discharge of waste water that could be recycled for reuse may not be ALARA or most cost-effective practice.	III	6.a Identify re-use applications and perform cost/benefit analysis.	3 mths	Operating	$50,000
				6.b Where justified by above, provide recycle capability and up-grade gunite tank(s) or install reservoir for recycle water storage.	9 mths (to install storage capacity)	Capital	$50,000 to $100,000 (to install storage capacity)
3.2.6	LIQUID LLW-Collection	7. Underground collection piping/tanks deteriorating. Concerns same as for LLW (see Item 2.); however, consequences of releases are more serious due to higher activity levels present.	I	7.a Proceed with project currently in design stage to replace transfer lines and replace/consolidate collection tks.	36 to 48 mths	Capital	$15 million
				7.b Increase project scope to include gravity drains from source bldgs to hold-up tanks and consolidate all hold-up tanks into two redundant tanks.	Included in 9.a	Capital	$10 million

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Priority Level	Recommendations: Summary Description	Estimated Project Duration	Type of Funding	Estimated Funding Level
				7.c Evaluate technical/economic benefits of alternatives, including elimination of hold-up tanks entirely.	6 mths	Capital	$150,000
3.2.7	LIQUID LLW-Sludge Disposal	8. Technical limitations and conflicts with potential future regulations may restrict or disallow continued use of hydrofracture facility.	II(1)	8.a Operating procedure changes to increase safe-guards for TRU waste disposal concentration limits.	NA	NA	NA
				8.b Develop conceptual design for backup above-ground solidification method. Coordinate with alternatives evaluation for solidification of LLW sludge & VR system products (Item 4.d).	6 mths (may be included in Item 4.d)	Capital	$250,000 (may be included in Item 4.d)
3.2.8	LIQUID HLW-General	9. Definition of HLW has led to uncertain and inconsistant policies on processing/disposal of these wastes. Resultant inter-laboratory policies on processing/disposal are inconsistent.	III	9. Develop quantitative definition of HLW and clear-cut, justifiable criteria for processing/disposal methodology. Identify need for generic R&D and safety evaluations to support this.	12 mths	Capital	$500,000
3.3.1	GRW-Collection/Discharge	10. Hot off gas/cell ventilation system for 3039 stack is obsolete. Components are inefficient and no longer reliable. Original safety and operational functions of system are threatened.	I	10.a Proceed with project currently in design phase to upgrade/replace system components to meet accepted design practices.	42 mths	Capital	$6.7 million
				10.b Conduct ALARA review of improvement project in Item 10.a.	3 mths	Capital	$50,000
				10.c Incorporate results of ALARA review in upgrade project.	Dependent on Item 10.b	Capital	Dependent on Item 10.b
				10.d Perform detailed inspection of underground portions of off gas/cell ventilation system and evaluate alternate corrective measures where needed.	6 mths	Operating	$100,000
				10.e Proceed with required corrective measures identified in Item 10.d	Dependent on Item 10.d	Dependent on Item 10.d	Dependent on Item 10.d

NOTE: (1) This could become a priority level I concer under certain conditions as discussed in Appendix B, page B.3-48.

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Priority Level	Recommendations: Summary Description	Estimated Project Duration	Type of Funding	Estimated Funding Level
3.4.1	DISCHARGE MONITORING/ CONTROL-Monitoring Equipment	11. Numerous design deficiencies in liquid/gaseous monitoring equipment. Qualitative rather than quantitative measurements. Lacks dynamic range capability. Lacks sufficient sensitivity. Operations limitation due to contamination of detector elements. Inadequate range for transient/accident conditions. Location of off gas monitoring equipment hazardous, not ALARA under accident conditions.	I	11.a Develop specification requirements for new equipment based on detail review of individual system operation parameters under normal/accident conditions.	12 mths	Capital	$100,000
				11.b Procure/install commercially available upgraded equipment.	18 to 27 mths	Capital	$1,100,000
				11.c Outline R&D program for equipment not commercially available.	Dependent on 11.a	Capital	Dependent on 11.a
				11.d Implement R&D program to develop needed equipment.	Dependent on 11.c	Capital	Dependent on 11.c
				11.e Review/adjust sampling frequency to complement on-line monitor capabilities.	Dependent on 11.a	Operating	Dependent on 11.a
				11.f Relocate monitoring equipment at base of Stack 3039.	Included in 11.b	Capital	Included in 11.b
3.4.2	DISCHARGE MONITORING/ CONTROL Interface with Data Acquisition System	12. Present DAS is being modernized without consideration being given to upgrade of front end monitoring equipment. Intercommunication not possible between new DAS and other new WOCC digital systems because of electronic incompatibilities.	I	12. Review/revise DAS specification to eliminate restrictions on future upgrade of front end monitoring equipment and to include intercommunication capabilities.	Completed	Operating	NA
3.4.3	DISCHARGE MONITORING/ CONTROL-Release Report Generation	13. Future regulations (such as R.G. 1.47) will require generation of numerous reports containing substantial data, calculated exposure, etc. These reports will require increased manpower to generate by hand.	III	13.a Determine modifications to computer-based DAS and existing digital analysis equipment required to enable automatic report generation.	9 mths	Capital	$50,000
				13.b Purchase/install necessary computer hardware.	Dependent on 13.a	Capital	Dependent on 13.a

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Current Conditions: Priority Level	Recommendations: Summary Description	Estimated Project Duration	Type of Funding	Estimated Funding Level
3.4	DISCHARGE MONITORING/ CONTROL-Misc. Release Points	14. Off-gas sources not routed to central off-gas stacks are not quantified in release reports as required by DOE Manual, Chapter 0513. Insufficient data available to determine adequacy of monitoring/ clean-up provisions.	III	14.a Document and periodically update list of all misc. release points. Maintain file of periodic manual samples of these releases to insure total is below reportable limits. Identify need for additional monitoring capability where applicable.	3 mths	Operating	$100,000
				14.b Install additional monitoring equipment where needed.	Dependent on 14.a	Capital	Dependent on 14.a
3.5.1	GENERAL WASTE MGMT-Facilities Consolidation	15. Processing, storage and disposal facilities are widely separated. Increased risk of personnel exposures and activity releases are not ALARA. Arrangement has also led to increased capital, operating and maintenance costs.	III	15. Develop a long-range plan for consolidating radwaste operations in one area (most likely at hydrofracture facility) as older systems are decommissioned and replaced.	6 mths	Operating	$100,000
3.5.2	GENERAL WASTE MGMT-Interface with Future D&D Projects	16. Future D&D projects could adversely affect waste management as a result of additional personnel exposure, incompatibility of wastes with process equipment, groundwater or airborne activity releases while handling wastes, and increased demand on waste collection/processing/storage/ disposal capabilities.	I	16.a Conduct detailed survey of physical/radiological conditions in surplus facilities.	9 mths	Capital	$300,000
				16.b Organize D&D project teams in manner that will insure major role by Waste Management Operations Group in policy decisions that will determine quantity/ characteristics of wastes.	NA	NA	NA
				16.c Comprehensive interdivisional study of alternate uses of surplus facilities before or after decon.	3 mths	Operating	$125,000
				16.d Comprehensive study to identify processing, solidification and disposal techniques for each expected waste types. Identify need for R&D and additions/ modifications to present radwaste systems.	3 mths	Operating	$75,000

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Current Conditions: Priority Level	Recommendations: Summary Description	Recommendations: Estimated Project Duration	Recommendations: Type of Funding	Recommendations: Estimated Funding Level
				16.e Carry out R&D efforts identified in above study.	Dependent on 16.d	Capital	Dependent on 16.d
				16.f Implement radwaste system changes dictated by above study.	Dependent on 16.d	Capital	Dependent on 16.d
3.5.3	GENERAL WASTE MGMT-Waste Generator Interface	17. Efficient optimization of waste management operations hindered by general lack of information or control over individual waste generators. Wastes are diluted and cross-contaminated before any sample data is collected.	III	17.a Establish computerized data acquisition program for recording and analyzing quantity/characteristics of individual inputs. Establish administrative procedure requiring individual source generators to submit weekly/monthly tabulation of estimated quantity/characteristics of waste generated for input to computer program.	6 mths	Operating	$150,000
				17.b As part of upgrade programs for LLW/ILW collection systems, install flow/radiation monitors and grab sample capability in drain line header from each building (Ref. Items 2.0 and 7.0).	Included in Items 2.0 & 7.0	Capital	Included in Items 2.0 & 7.0
3.5.4	GENERAL WASTE MGMT-Design Documentation	18. Design documentation in some areas is inadequate for understanding system design, evaluating performance of the system, and periodic assessment of conformance of the system to current safety/regulatory practices. Documentation is at times inaccurate or incomplete. No standard format for presenting, recording, maintaining and updating documents. Semi-manual document records keeping further complicates retrieval for review/revision.	II	18.a Develop comprehensive system description/process diagram to encompass all phases of liquid, solid and gaseous waste collection, processing and disposal. Maintain as single authoritative source of all design information for all subsystems. Include updating of all related design documents as part of this project.	Integrate with individual system upgrade projects	Capital	$300,000
				18.b Computerized system for filing/retrieval of all design documents/operating records.	Same as Item 19.a	Capital	$200,000
				18.c Set up dual records keeping system for protection against loss due to fire, water damage, etc.	3 mths (to eval- system)	Operating	$50,000 (to evaluate system)

TABLE 2.3-1 SUMMARY OF RECOMMENDED IMPROVEMENTS (Cont'd)

Reference Subsection Appendix B	WASTE MANAGEMENT CATEGORY and Functional Activity	Current Conditions: Summary Description	Priority Level	Recommendations: Summary Description	Estimated Project Duration	Type of Funding	Estimated Funding Level
3.5.5	GENERAL WASTE MGMT-ALARA Program	19. ALARA criteria may not be fully satisfied in all areas of waste management operations. Obstacles to full compliance with ALARA include: a) large volumes of waste handled; b) high activity levels of some wastes; c) physical separation between facilities; d) deteriorated condition of some facilities; e) out-moded design of some older facilities; and f) emphasis on non-nuclear R&D work in recent years.	III	19.a Establish independent ALARA review board to review/approve future modifications to system design and operating procedures that would have an impact on compliance with ALARA.	NA	Operating	NA
				19.b Support efforts by health physics division to develop computer-based means of correlating worker exposures to work tasks for trending studies and planning maintenance/modification/decontamination/decommissioning projects.	NA	Operating	NA

TABLE 2.3-2 SUMMARY OF NEEDED IMPROVEMENTS BY PRIORITY LEVEL

PRIORITY LEVEL	WASTE MANAGEMENT CATEGORY[1] SOLID WASTE	LIQUID WASTE	GASEOUS WASTE	MONITORING/CONTROL	GENERAL
I		3.2.3 - ALARA concerns associated with use of open pits for LLW sludge disposal. 3.2.6 - Deteriorating condition of ILW collection tanks and piping.	3.3.1 - Outdated/inefficient design of ventilation equipment. Deteriorating condition of ductwork and off gas piping. (Both buried above-grade portions.)	3.4.1 - Outdated/inaccurate front end monitoring equipment. 3.4.2 - Deficiencies in communication capabilities between new DAS and other WOCC digital systems.	3.5.2 - Impact of proposed surplus facilities D&D projects on waste management facilities/practices.
II	3.1.1 Excess land usage in design of future SWSA's	3.2.4 - Lack of ready means to dispose of contaminated oil.	-	3.4.4 - Insufficient reporting and/or monitoring of local release	3.5.4 - Inadequate design documentation practices with regard to development, content, revision control and storage/retrieval.
III	3.1.1 Uncontrolled migration of nuclides from existing SWSA's	3.2.1 - Deteriorating condition of LLW collection piping. 3.2.2 - ALARA concerns and operational disadvantages associated with open/unlined LLW collection basins. 3.2.5 - Full potential for recycling processed water has not been utilized. 3.2.7 - Technical/Regulatory issues may delay approval to hydrofracture ILW sludge. No provisions have been made for alternative means of ILW disposal. 3.2.8 - Inconsistent policies on hazards and handling of HLW.	-	3.4.3 - Lack of efficient means of report generation to handle expected increases in reporting requirement.	3.5.1 - Widely separated radwaste facilities are inefficient to operate and are not conducive to satisfying ALARA criteria. General lack of plans for centralizing/consolidating future facilities. 3.5.3 - General lack of information or control of specific waste inputs and resultant inability to plan and control waste management operations in manner that is most efficient and responsive to ALARA. 3.5.5 - Lack of formal program to achieve ALARA objectives in system design and operation.

NOTE:

1. Subsection numbers refer to those in Section 3.0 of Appendix B.

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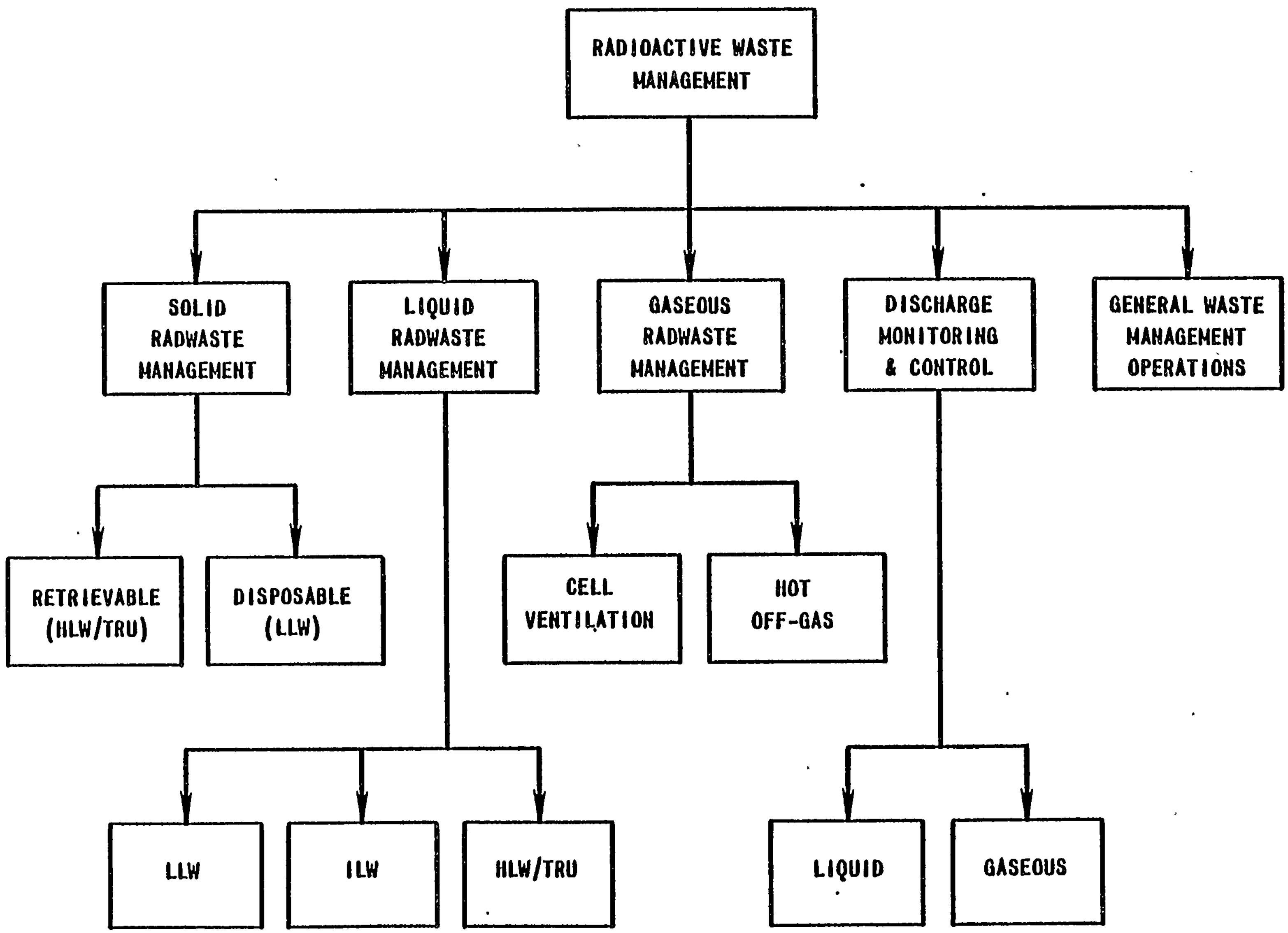

FIGURE 2.3-1 PRINCIPLE BREAKDOWN STRUCTURE USED IN REVIEWING ORNL'S WASTE MANAGEMENT OPERATIONS

3.0 PLANNING/SCHEDULING OF RECOMMENDED IMPROVEMENTS

The improvement plans described in this section are the first step in developing a comprehensive ORNL radioactive waste management improvements implementation plan. The information in previous sections describes the recommended alternatives for improvement of the ORNL radioactive waste management operations. This section describes the recommended approach to development of the long-range implementation plan. It includes: 1) a recommended program structure which provides the framework of a comprehensive program work breakdown structure (PWBS); and 2) a recommended program logic which describes the steps to be taken to identify, scope, time phase and budget each improvement project from inception to operation.

3.1 IMPROVEMENT PROGRAM STRUCTURE

The purpose of the recommended improvement program structure is to organize the improvements in the way DOE requires work and budgets to be organized and controlled. The structure is a hierarchical "system" oriented breakdown which first identifies the major categories of radioactive waste (i.e., solid, liquid or gaseous). These are further broken down into the types or levels of waste and their associated waste management systems.

Figure 3.1-1 describes the first two levels of the PWBS. The first level is intended to capture all elements of the ORNL radwaste management operations and facilities which may be subject to the improvement program, including the monitoring/control systems, and the management and administration of the ORNL radwaste operations and facilities. The second level then identifies each project under a specific facility or operational category. The projects are identified with the appropriate reference subsection number from Section 3.0 of Appendix B, where more detailed descriptive information is given about each project.

Within each of the terminal level program elements a number of improvement projects or activities may be identified. When a specific improvement is identified and selected for implementation, that improvement will become the subject of an improvement project. At that time a project work breakdown structure will be developed which identifies and hierarchically structures the elements and activities of the improvement project in accordance with established UCC-ND procedures for project planning.

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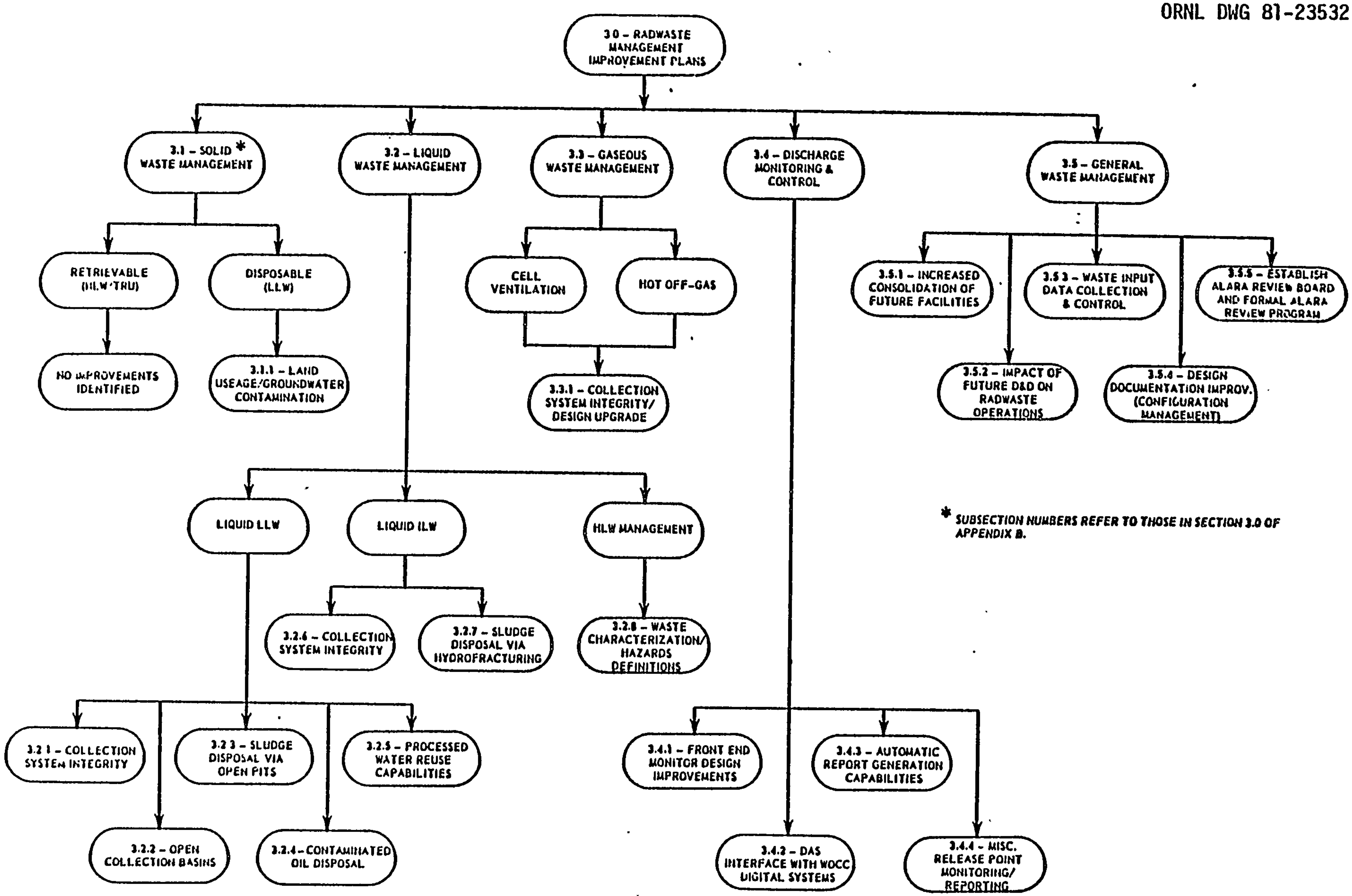

* SUBSECTION NUMBERS REFER TO THOSE IN SECTION 3.0 OF APPENDIX B.

FIGURE 3.1-1
SUMMARY LEVEL IMPROVEMENT PROGRAM WORK BREAKDOWN SCHEDULE *

3.2 IMPROVEMENT PLANNING

3.2.1 Program Planning Logic

The recommended program planning logic describes the steps required for implementing each improvement. Figures 3.2-1 and 3.2-2 describe these steps from characterization and assessment of the waste management system through the identification and decision-making process of executing an improvement project. This diagram concentrates on Phase 1 planning and decisions which ORNL and DOE must accomplish in order to select improvement projects for implementation of subsequent phases.

3.2.2 Project Planning Logic

Figure 3.2-3 describes the phases in the evaluation of a major project from concept through construction and acceptance. Some of the improvement projects may not be of sufficient size or complexity to warrant such a detailed evaluation. In such cases, some of the steps or phases may be eliminated or combined. In other cases, the improvement definition may be sufficient to enable leapfrogging the earlier phases and immediately initiating Titles I and II, Engineering and Construction. The process shown is derived from the new DOE Project Management System Handbook DOE/CR-0019, and is generally in accord with the guidelines of the older AEC Manual Appendix 6101, "Management of Construction Projects," which is accordingly being rewritten by DOE.

3.2.3 Decision Networks of Improvement Options and Alternatives

The purpose of this process is to enable the ORNL radioactive waste management operation to review and evaluate the improvement options available to them, and to make the necessary management decisions leading to implementation of improvements. Each radwaste management system and process which is a candidate for improvement will be the subject of a decision network which begins with the potential problem, considers the alternatives, describes the sequential activities which must take place to implement each alternative, and provides management with the rationale for the trade-offs and decisions to be made throughout the evaluation of the alternatives. Each of the decision networks generally follows the sequence of events described in Figures 3.2-1 and 3.2-2.

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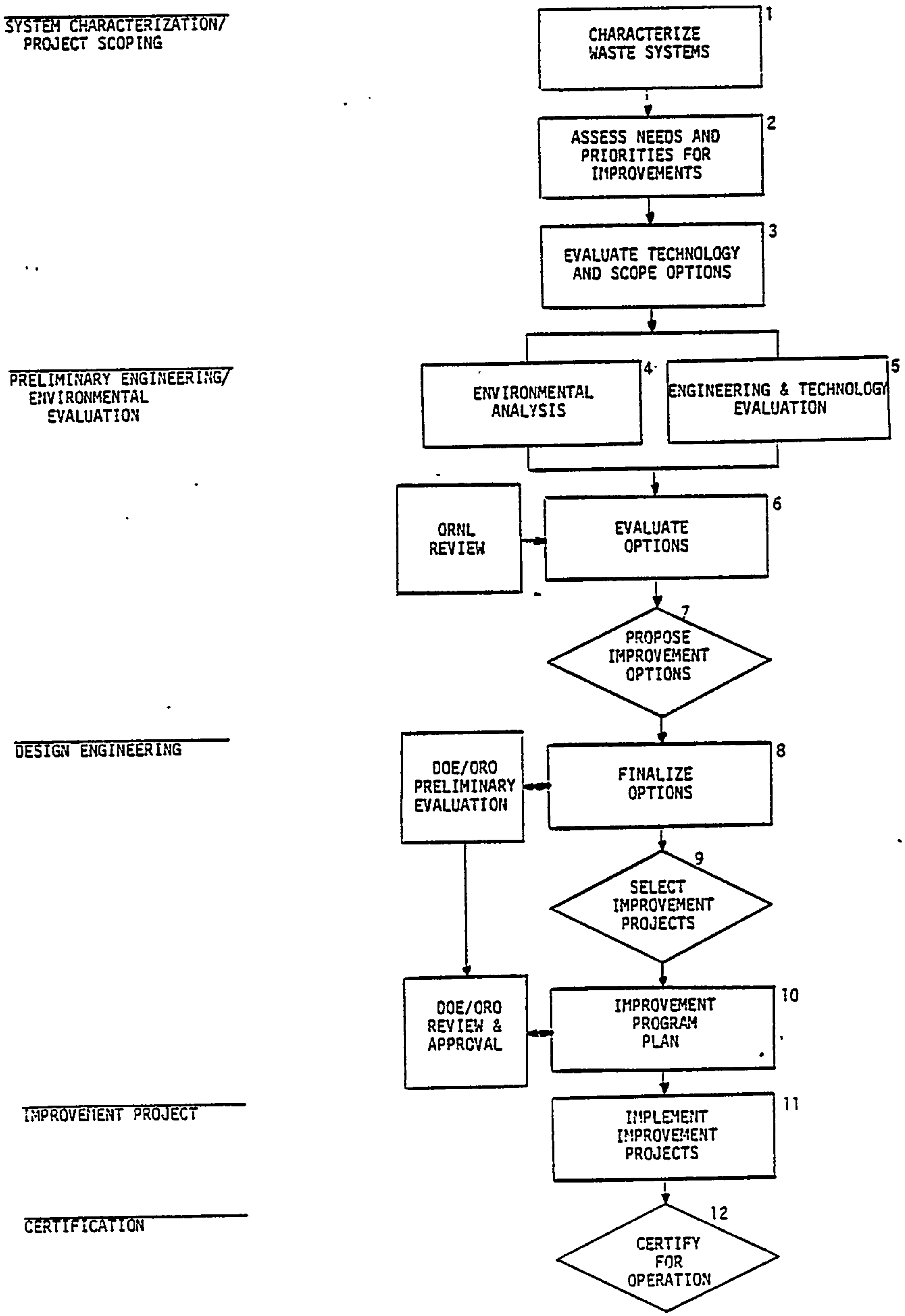


FIGURE 3.2-1 ORNL RADWASTE IMPROVEMENT PROGRAM LOGIC

FIGURE 3.2-2 RADWASTE IMPROVEMENT PROJECT LOGIC

STEP NO.	ELEMENT	DESCRIPTION	DECISION
1	Characterize Waste System	Perform exploratory surveys to estimate extent and type of contamination and environmental hazards.	
2	Assess Needs And Priorities For Improvements	Compare survey results with guidelines; assess health risks; relate to current regulations and DOE policy.	Is there a need for improvements? What is the health/risk priority?
3	Evaluate Technology And Scope Options	Identify principal issues/technical problems to be addressed. Develop initial project plan to outline the required remedial action steps and initiate screening process for alternate solutions.	Determine issues and problem areas.
4	Environmental Analysis	Analysis will address hazard identification, environmental characterization, hydrology and geology considerations. The assessment will discuss the environmental impacts of the present practices and proposed modifications.	
5	Engineering & Technology Evaluation	Collect and analyze engineering data to supplement characterization of the present situation and develop options. The evaluation of each option will include schedule, costs, risks, and benefits.	Determine if engineering and environmental data are sufficient to choose and justify proposing an option. Determine effect on lab operations by construction.
6	Evaluate Options	Review each option and obtain comments on results of engineering evaluation and environmental analysis.	Select the preferred option and reasonable alternatives which are worth pursuing.
7	Propose Improvement Options	Describe the preferred option to DOE-ORO. Prepare the Project Plan	DOE approval.
8	Finalize Options	Conducted required research or field tests to obtain environmental data and prepare an Environmental Assessment or Environmental Impact Statement, if needed.	
9	Select Improvement Projects	Prepare Record of Decision to select an option and obtain DOE approval.	DOE approval.
10	Improvement Project Plan	Prepare a detailed engineering plan including cost estimate, work plan, environmental protection requirements, schedules, and technical specifications for the improvements.	
11	Implement Improvement Program	Contractor selected by competitive procurement will implement the improvement project as outlined in the Project Plan.	
12	Certify For Operation	During the project and following its completion, a monitoring program will be established to verify the effectiveness of the improvement. A final report and statement will be prepared by ORNL to certify the site or system for operation.	Operations may proceed.

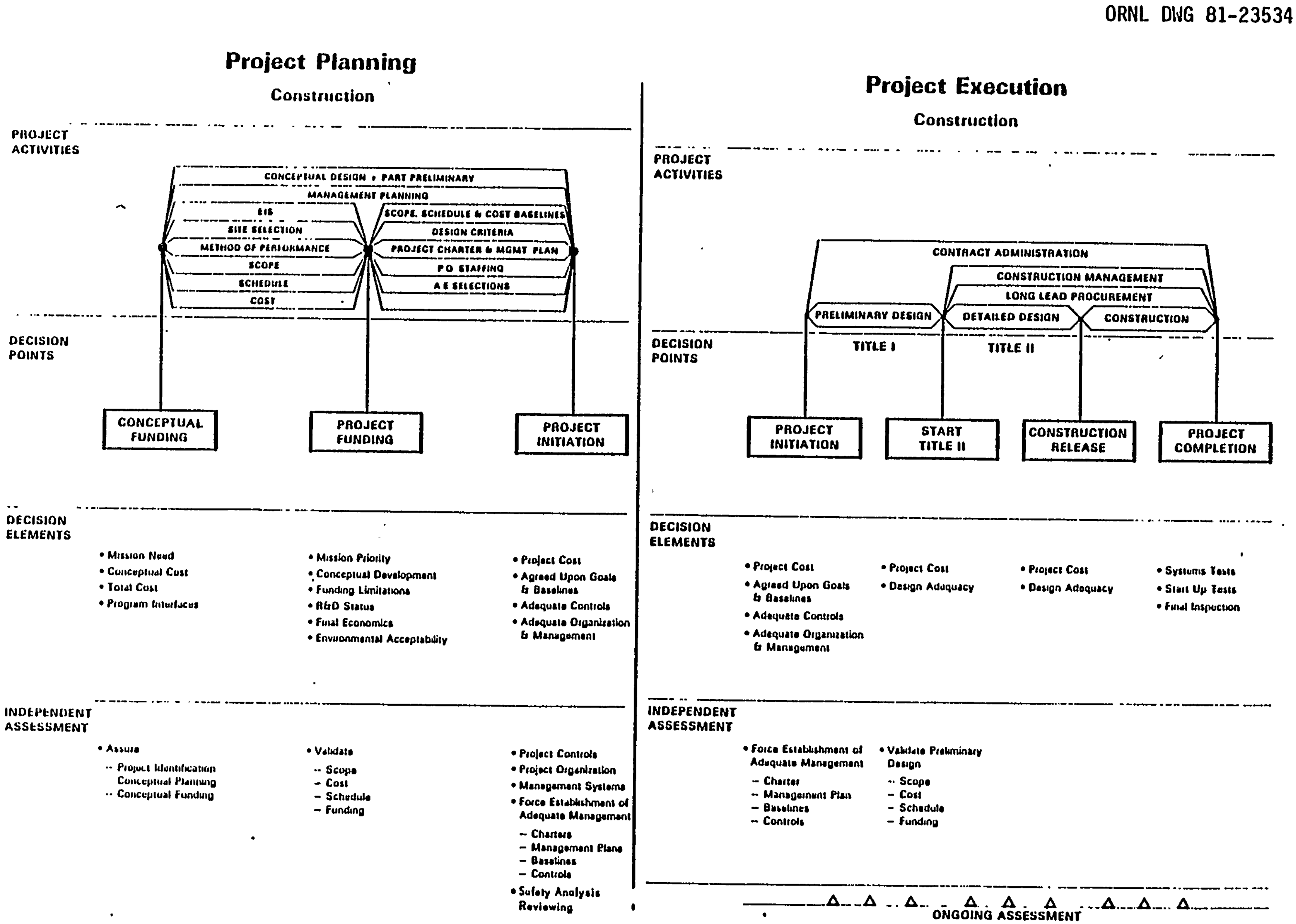


FIGURE 3.2-3 PROJECT PLANNING AND EXECUTION

3.2.4 Detailed Networks of Each Improvement Recommendation

3.2.4.1 Solid Radioactive Waste Management
SRW Processing/Disposal

Site geology/hydrology conditions were not adequately considered for waste disposal operations prior to opening SWSA-5. A large portion of the activity released to the environment originates in leachant from these older burial sites. Newer disposal operations, while adequately compensating for ORNL's site conditions, require the use of more land area per unit volume of waste. This is compounded by a lack of ultimate volume-reduction capability for some waste forms.

ORNL DWG 81-23535

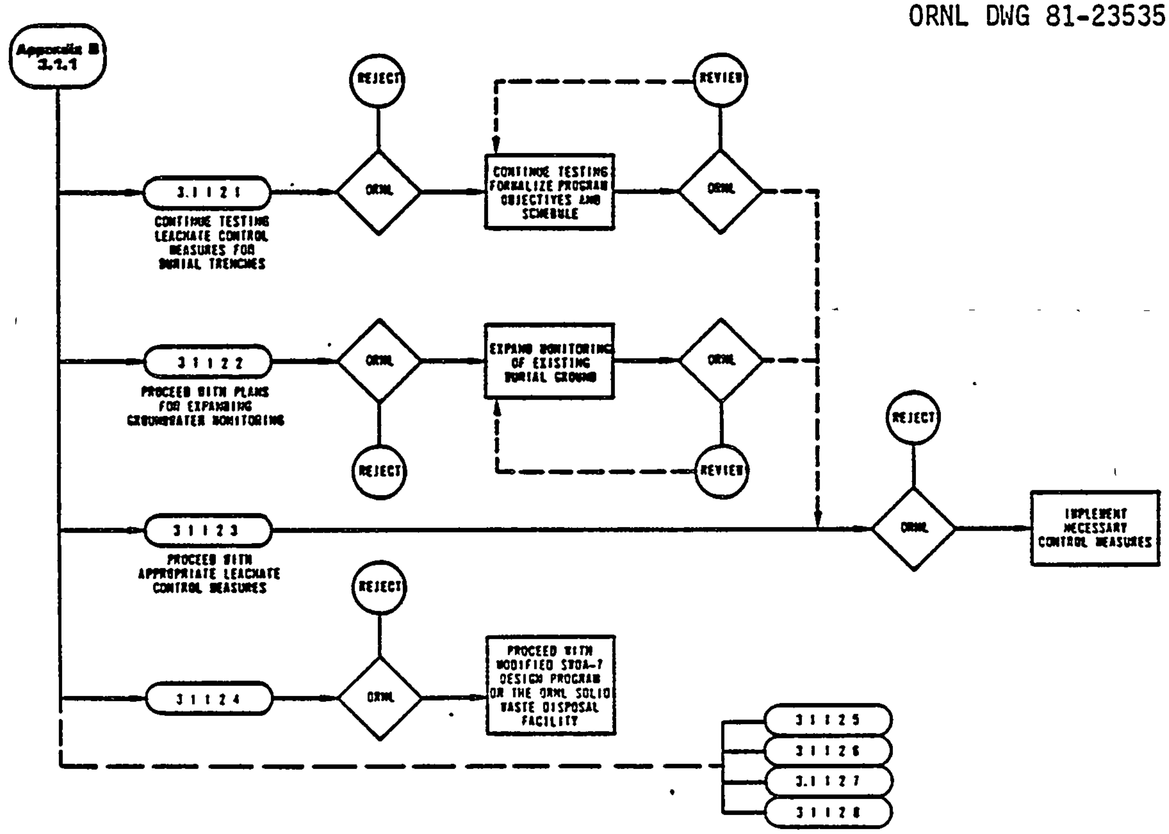


FIGURE 3.2-4, SHEET 1, DECISION NETWORK - SRW PROCESSING/DISPOSAL

ORNL DWG 81-23536

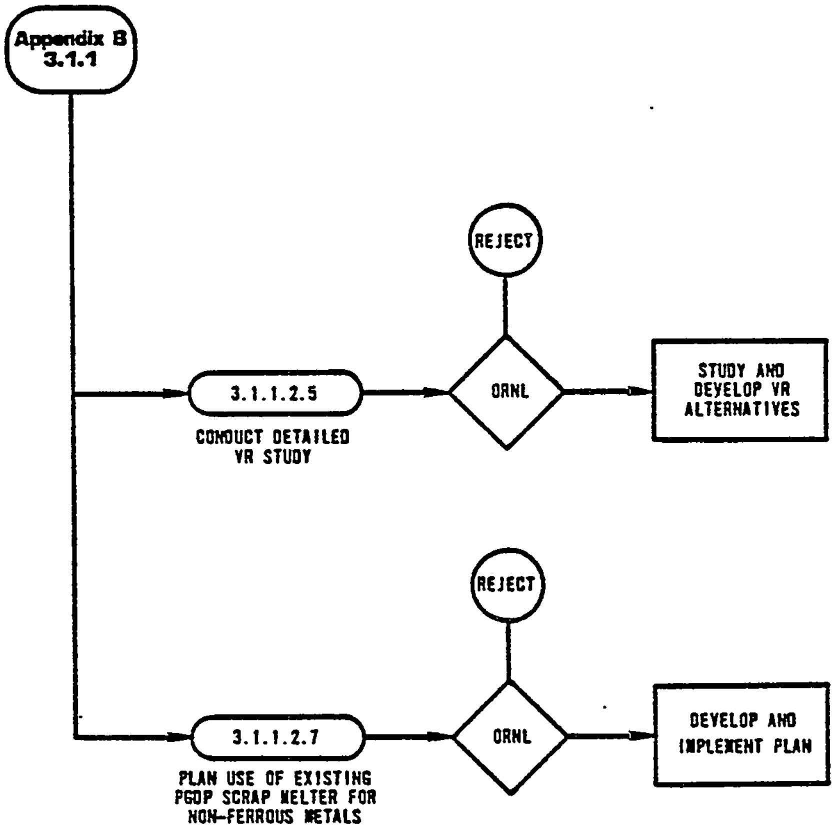


FIGURE 3.2-4, SHEET 2, DECISION NETWORK - SRW PROCESSING/DISPOSAL

3.2.4.2 Liquid Radioactive Waste Management
Liquid LLW Collection

A complete assessment of the underground collection system piping cannot be made due the lack of complete historical information on the atlas drawings. However, much of the vitrified clay pipe was installed more than 30 years ago, and there are indications that the system is leaking. The resultant in-leakage and out-leakage create several undesirable conditions. In-leakage increases the load on process equipment, and hence, operating costs. Uncontrolled and unmonitored out-leakage is not consistent with ALARA philosophy. The ability to quantify these conditions in the system is inadequate.

ORNL DWG 81-23537

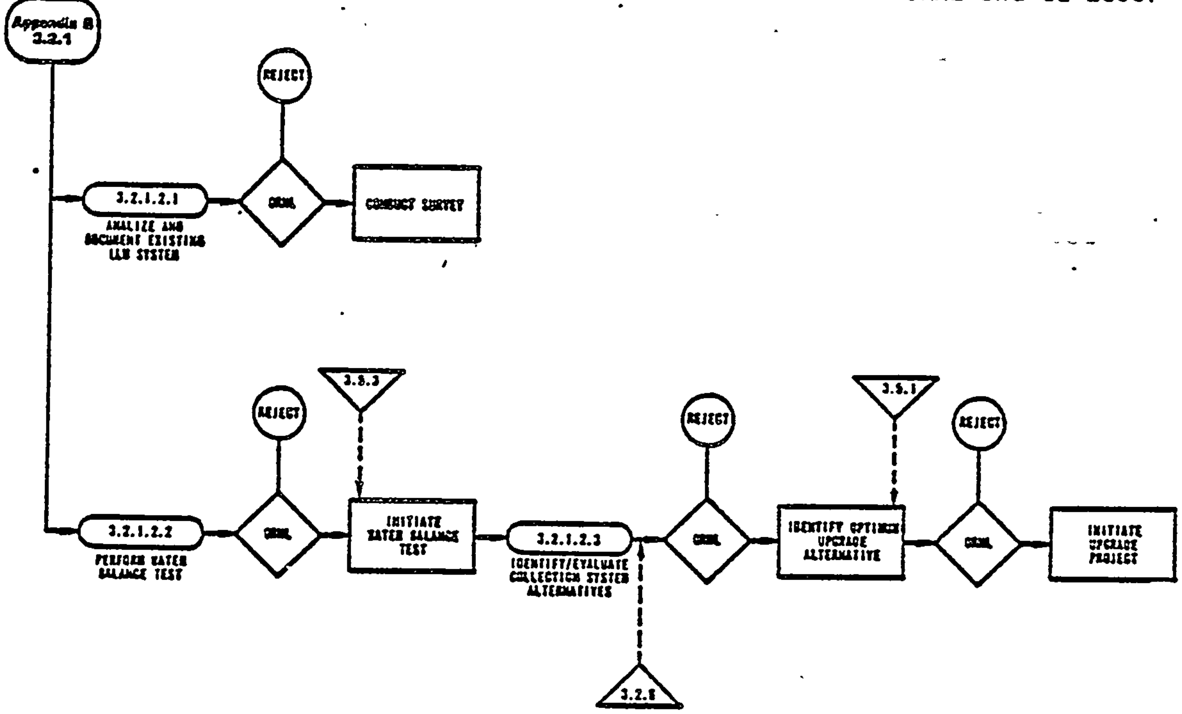


FIGURE 3.2-5 <u>DECISION NETWORK - LLW COLLECTION</u>

3.2.4.3 Liquid Radioactive Waste Management
Liquid LLW Processing

Process Waste Basin 3524 and Process Waste Ponds 3539 and 3540 may not be in full compliance with ALARA criteria. Being uncovered, they allow contamination to be spread by animals and insects that come in contact with the contents. Wind also picks up and spreads dried material from the banks of the ponds. Exposed to the elements, precipitation is collected in these areas, adding to the load on the LLW processing equipment. Uncontrolled evaporation releases radionuclides to the atmosphere. Those basins that are unlined may also allow radionuclides to migrate to the ground water.

ORNL DWG 81-23538

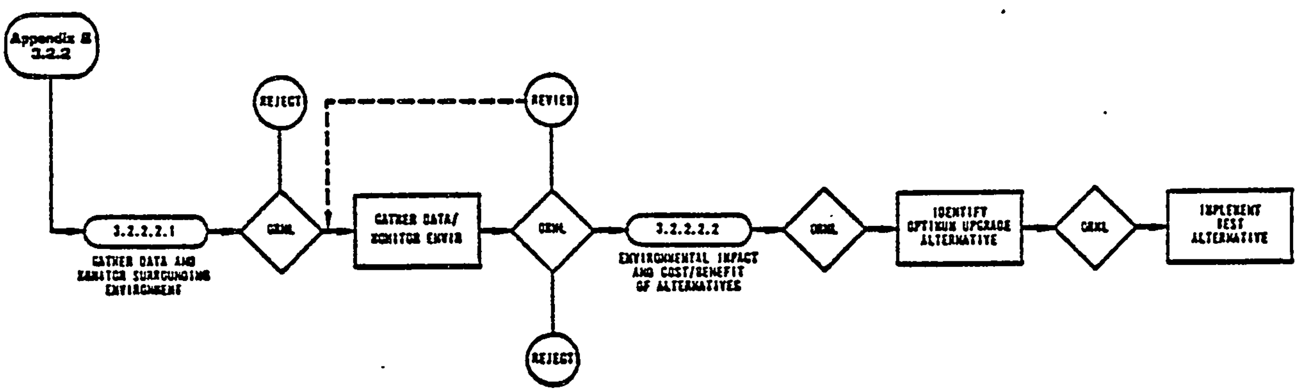


FIGURE 3.2-6 DECISION NETWORK - LLW PROCESSING

3.2.4.4 Liquid Radioactive Waste Management
Liquid LLW Sludge Disposal

Although lined, the use of open pits is not an acceptable long-term practice for LLW sludge disposal. Both the NRC and the DOE consider it is non-ALARA because of the potential for uncontrolled and unmonitored releases of contaminated matérial into the environment.

ORNL DWG 81-23539

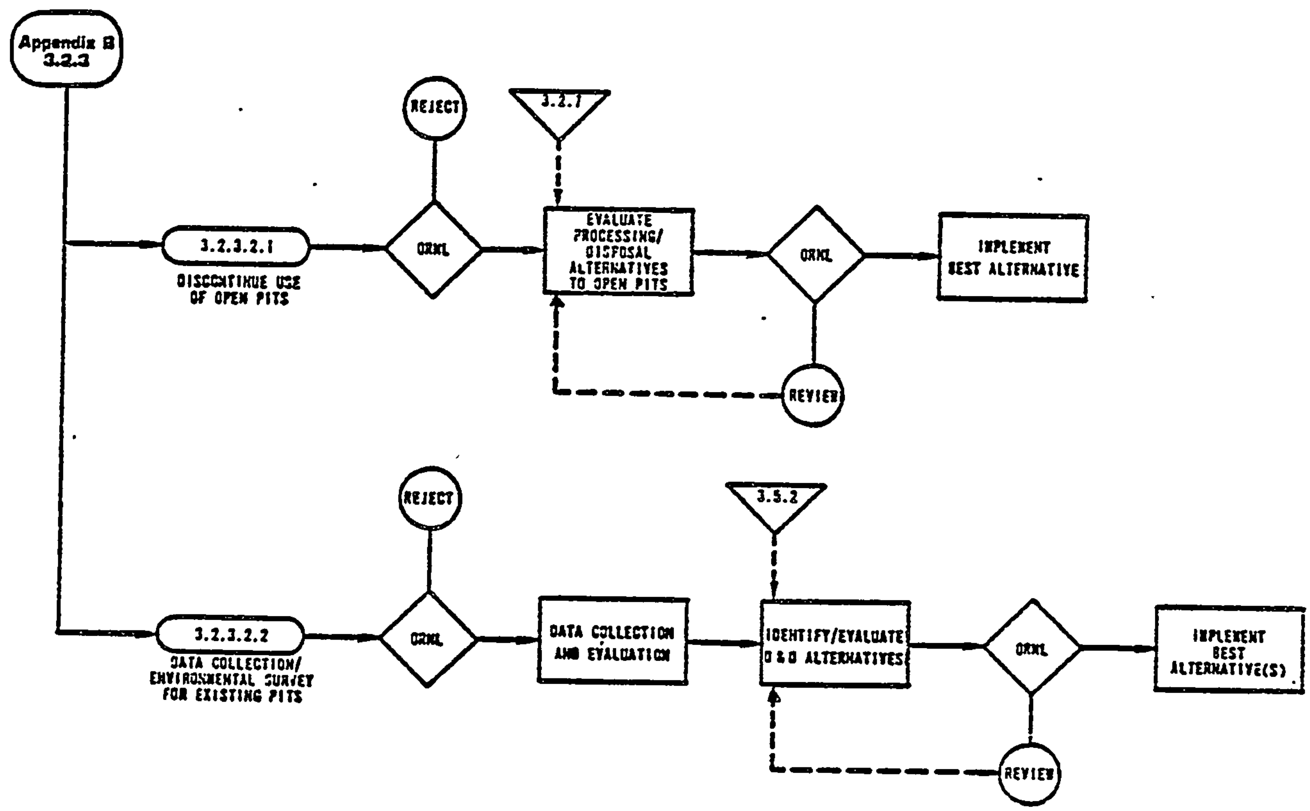


FIGURE 3.2-7 DECISION NETWORK - LLW SLUDGE DISPOSAL

3.2.4.5 Liquid Radioactive Waste Management
Liquid LLW - Contaminated Oil Disposal

In the long term, the present practice of disposing contaminated oil in tanks is not practical or safe. Large quantities of contaminated oil are a fire hazard in themselves, and the danger is compounded by the uncontrolled quantities of radiation that would be carried into the atmosphere with the combustion products. Burial would not be an acceptable disposal technique if commercial shallow land burial guidelines were followed, since these facilities do not accept waste containing more than one percent oil.

ORNL DWG 81-23540

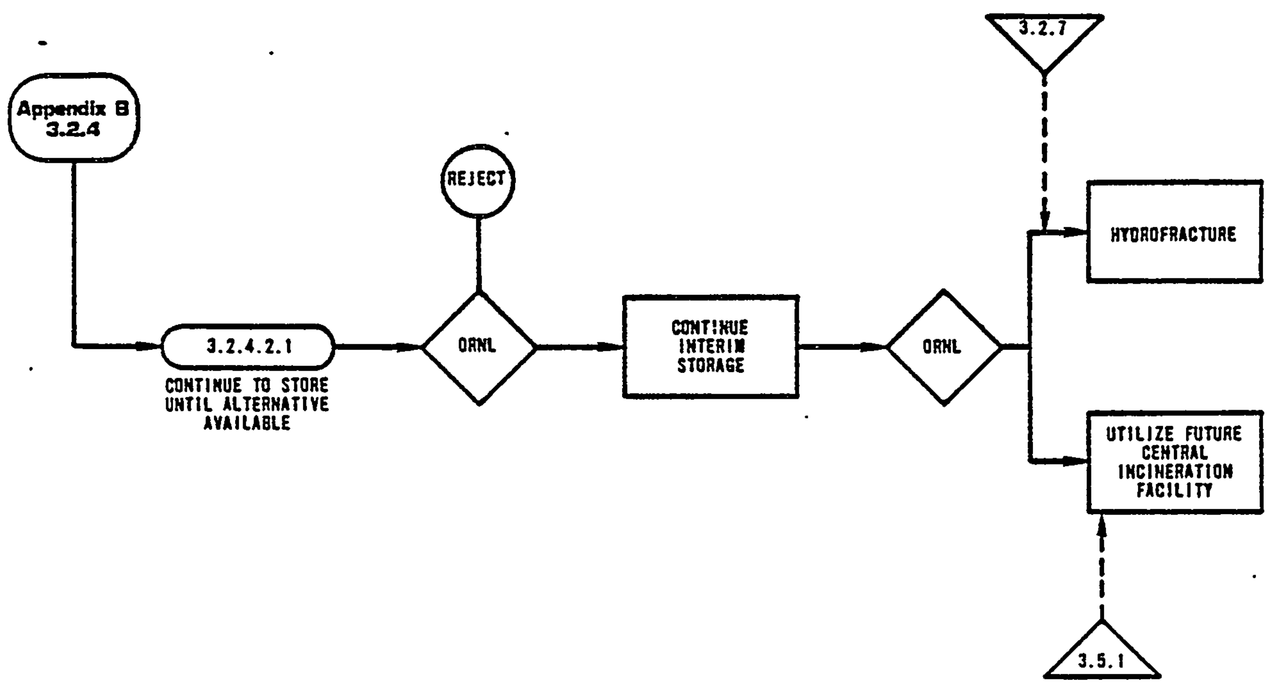


FIGURE 3.2-8 DECISION NETWORK - CONTAMINATED OIL DISPOSAL

3.2.4.6 Liquid Radioactive Waste Management
Liquid LLW - Discharge/Recycle

The processing of LLW at ORNL results in a total yearly discharge well within the guidelines set by the NRC. However, since it may be cost-effective to recycle this treated water for reuse, even the small quantities of activity now being released from the LLW system may not be ALARA.

ORNL DWG 81-23541

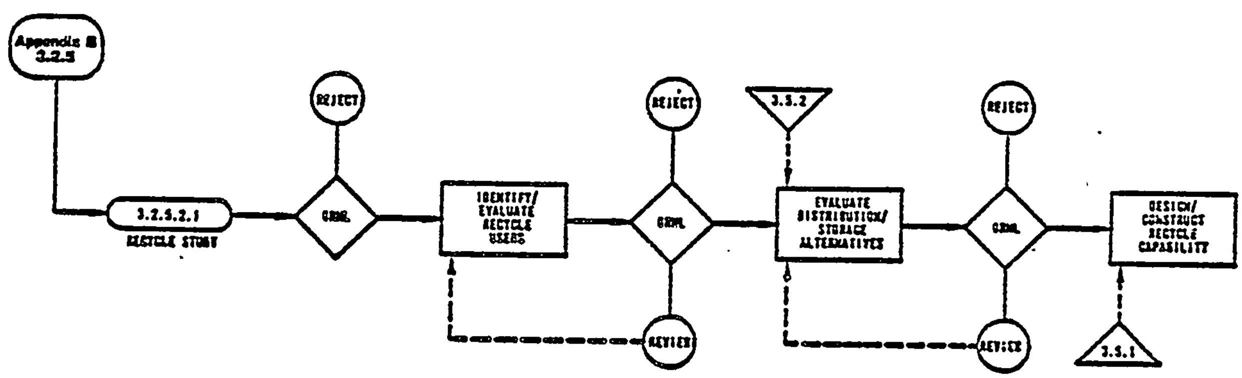


FIGURE 3.2-9 DECISION NETWORK - LLW DISCHARGE/RECYCLE OPTIONS

3.2.4.7 Liquid Radioactive Waste Management
Liquid ILW Collection

The integrity of the 304SS piping in this system is suspect due to the corrosive effects of both the internal and external environment over the past 30 to 40 years. Internally, the piping is exposed to a wide range of acid/caustic conditions. Externally, the piping is in direct contact with the soil without benefit of cathodic protection. At times it is also in direct contact with ground water. The buried intermediate holdup tanks are subject to the same conditions. Some tanks and piping have already failed. This situation could lead to uncontrolled and unmonitored releases that are not within ALARA guidelines.

ORNL DWG 81-23542

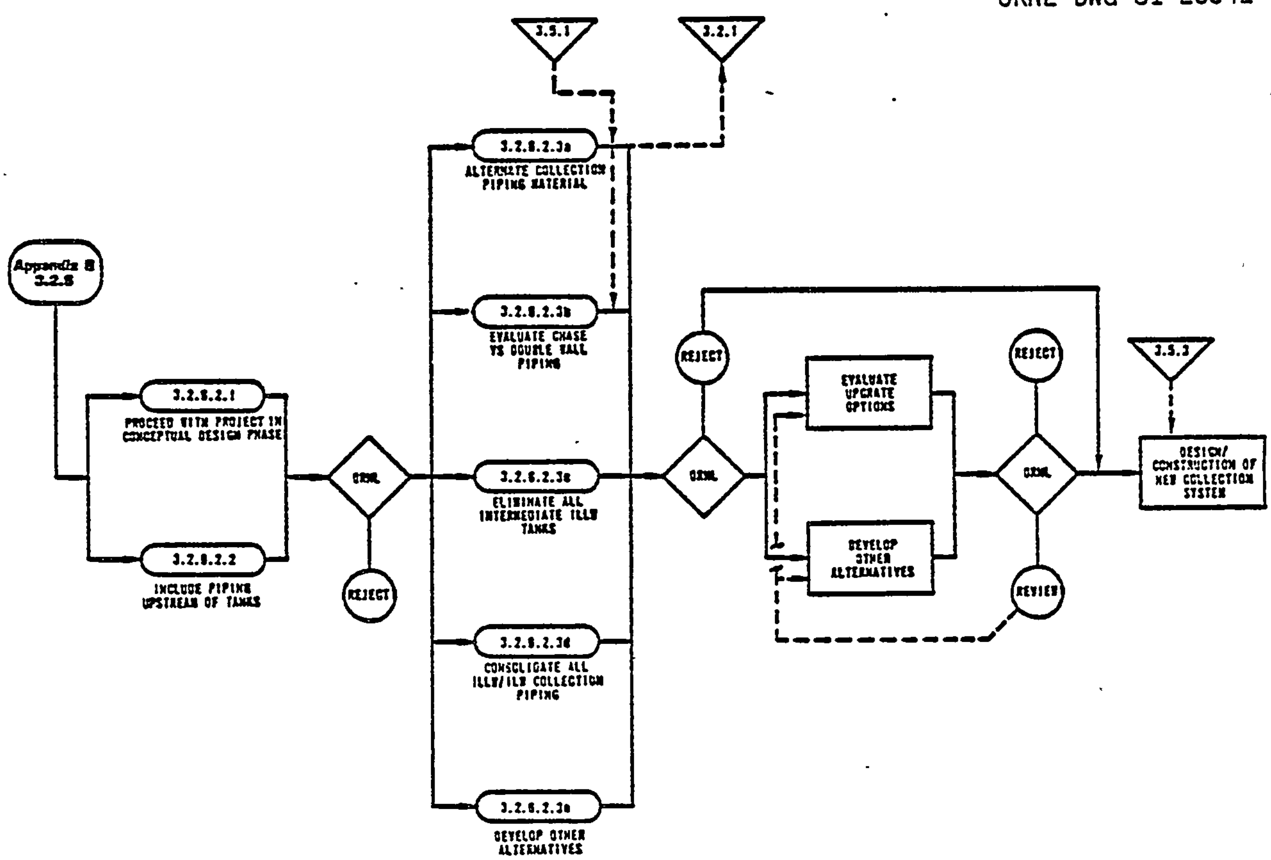


FIGURE 3.2-10 DECISION NETWORK - ILW COLLECTION

3.2.4.8 Liquid Radioactive Waste Management
Liquid ILW Sludge Disposal

For a number of years, hydrofracturing has been used to dispose of all ILW wastes at the Laboratory. There is a possibility that future regulations may restrict or prohibit the continued use of this technique. Should this occur, ORNL's operations would be severely disrupted until an alternate disposal technique were available.

ORNL DWG 81-23543

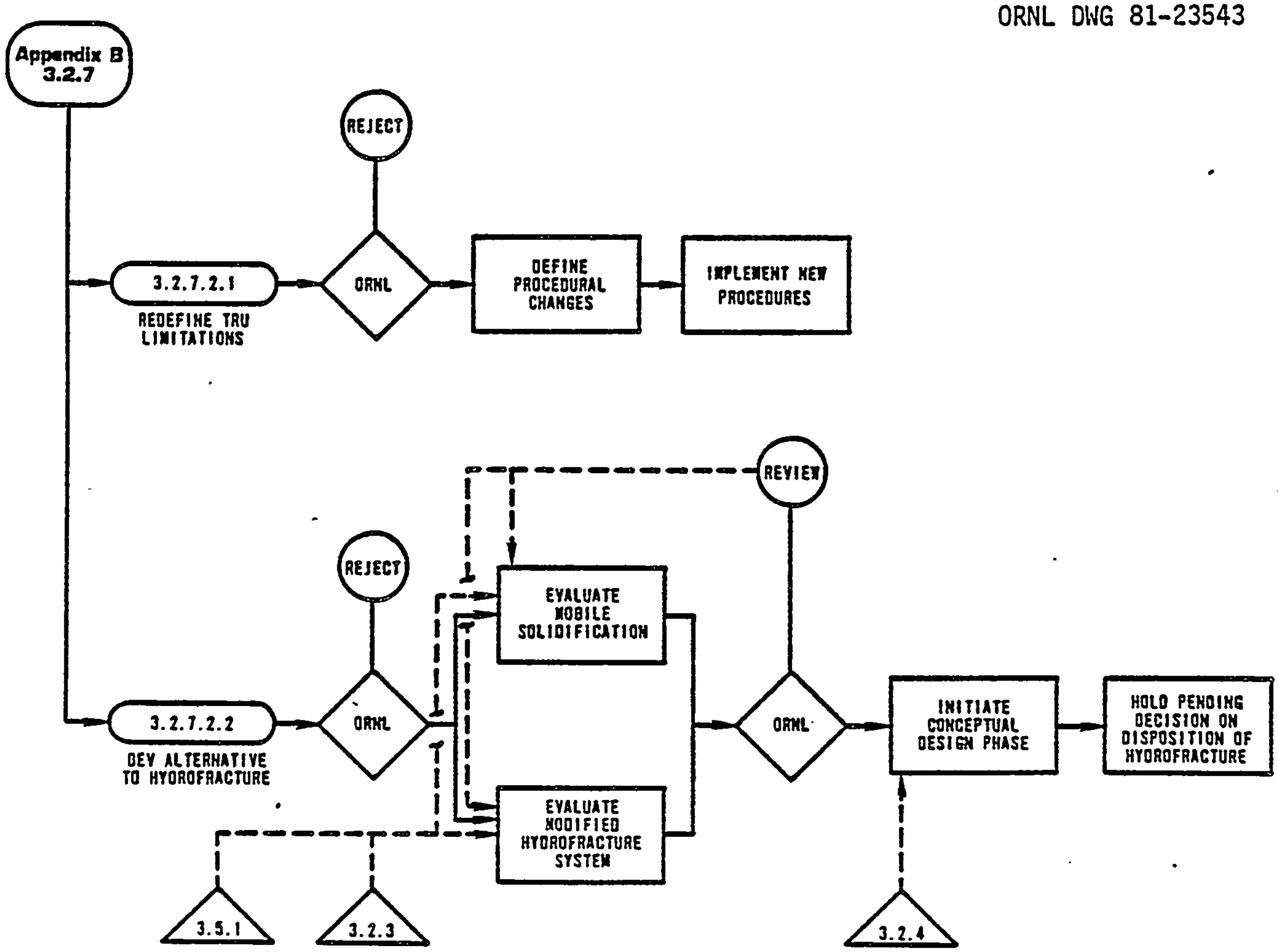


FIGURE 3.2-11 DECISION NETWORK - ILW SLUDGE DISPOSAL

3.2.4.9 Liquid Radioactive Waste Management
Liquid HLW Classification

DOE'S definition of HLW is imprecise. Classification of a particular waste has a direct bearing on the collection, processing, storage and disposal techniques that will be applied to it. Each of these techniques, in turn, has its associated cost. If a classification is not more precisely defined and not uniformly adopted, insufficient safeguards could be applied under certain conditions, and unnecessary costs could result by applying overly conservative safeguards in others.

ORNL DWG 81-23544

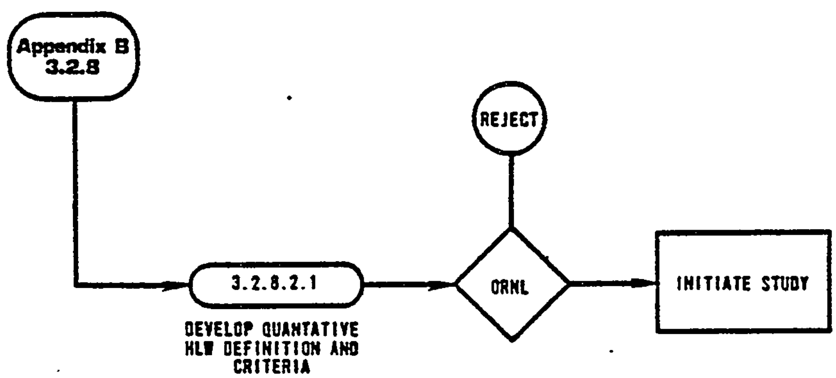


FIGURE 3.2-12 DECISION NETWORK - HLW CLASSIFICATION

3.2.4.10 Gaseous Radioactive Waste Management GRW Collection/Discharge

The off-gas and cell ventilation equipment at the base of Stack 3039 is outmoded and in a general state of disrepair. The above-ground portion of the ductwork is known to be failing, and it is suspected that the below-grade portions of both ventilation ductwork and off-gas piping are also failing. Leakage into the ductwork could cause a hazardous buildup of airborne contamination in respective source generator buildings by displacing part of the air volume that should be drawn from the building. Leakage out of the pressurized, above-ground portions of the system could also result in hazardous conditions. Present design and layout of portions of the system may not conform to ALARA criteria.

ORNL DWG 81-23545

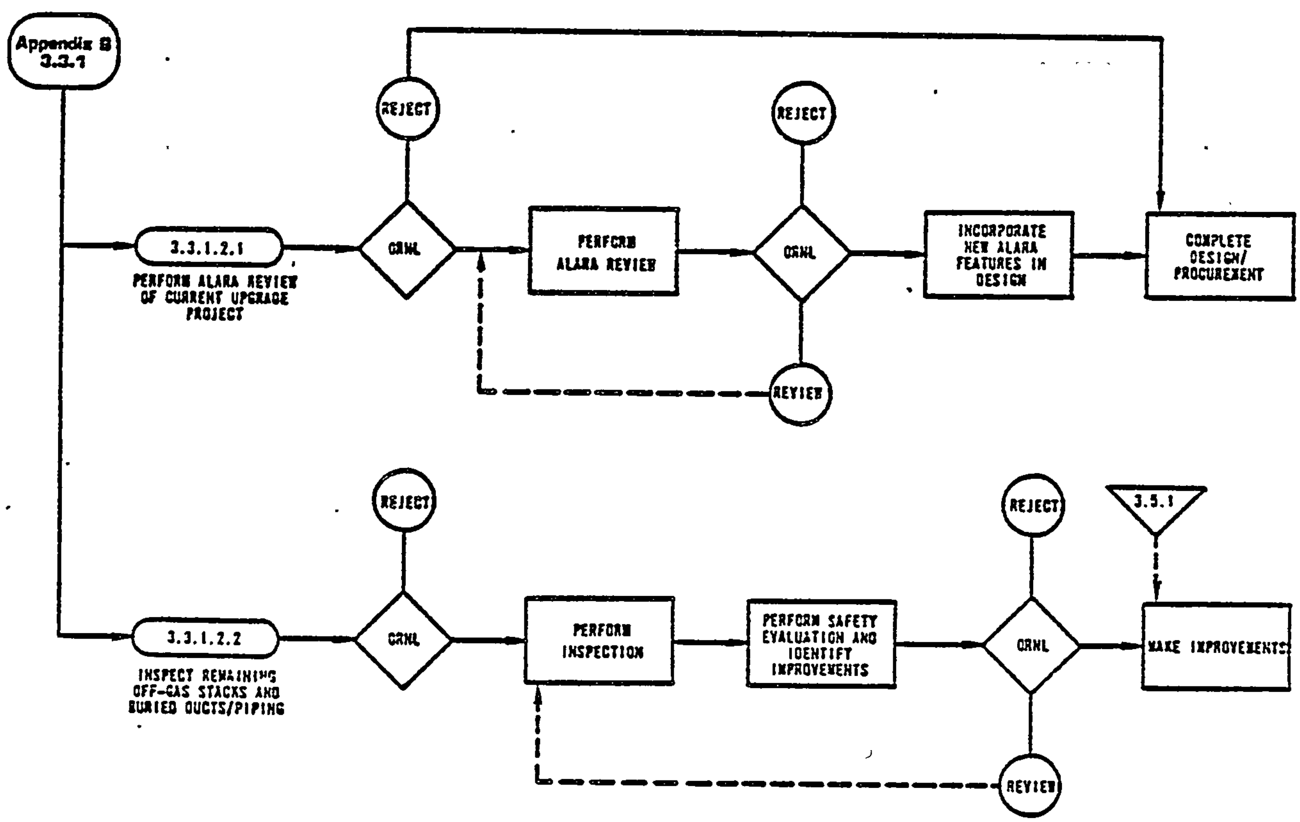


FIGURE 3.2-13 DECISION NETWORK - GRW COLLECTION/DISCHARGE

3.2.4.11 Discharge Monitoring/Control
Front End Radiation Monitoring Equipment

The existing radiation monitoring equipment provides qualitative rather than quantitative measurements. The detectors do not provide sufficient sensitivity and lack dynamic range capability. In general, equipment capabilities and installation do not conform with accepted industry standards.

ORNL DWG 81-23546

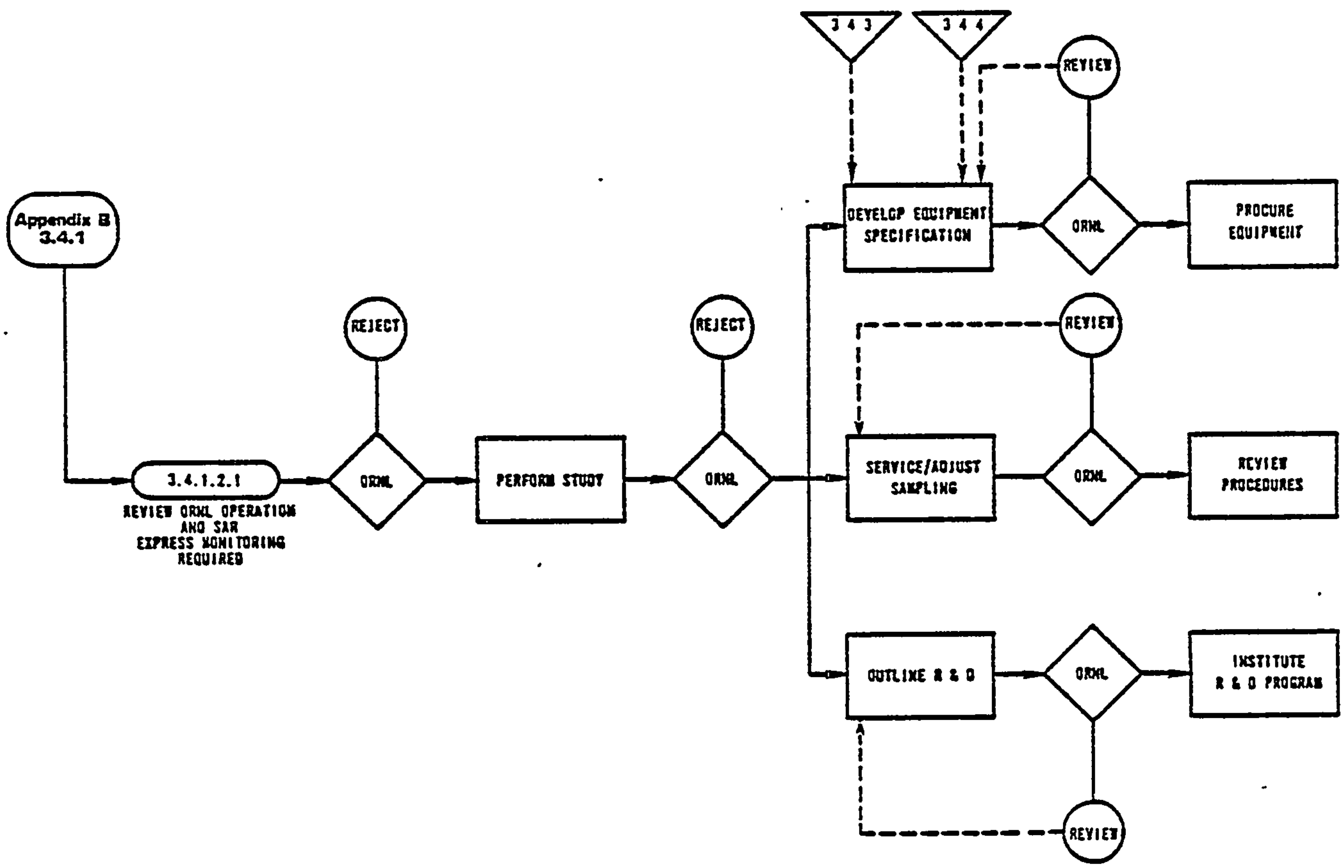


FIGURE 3.2-14 DECISION NETWORK - RADIATION MONITORING EQUIPMENT

3.2.4.12 Discharge Monitoring/Control Interface with Data Acquisition System

The modernization of the existing DAS has a direct impact on future upgrade projects relating to radiation detection. The full capabilities of the actual measuring devices may be restricted if the new digital DAS cannot process the various input signals. Presently, 'system talk' is not possible due to the electronic incompatibilities between the new DAS and other new WOCC digital systems.

ORNL DWG 81-23547

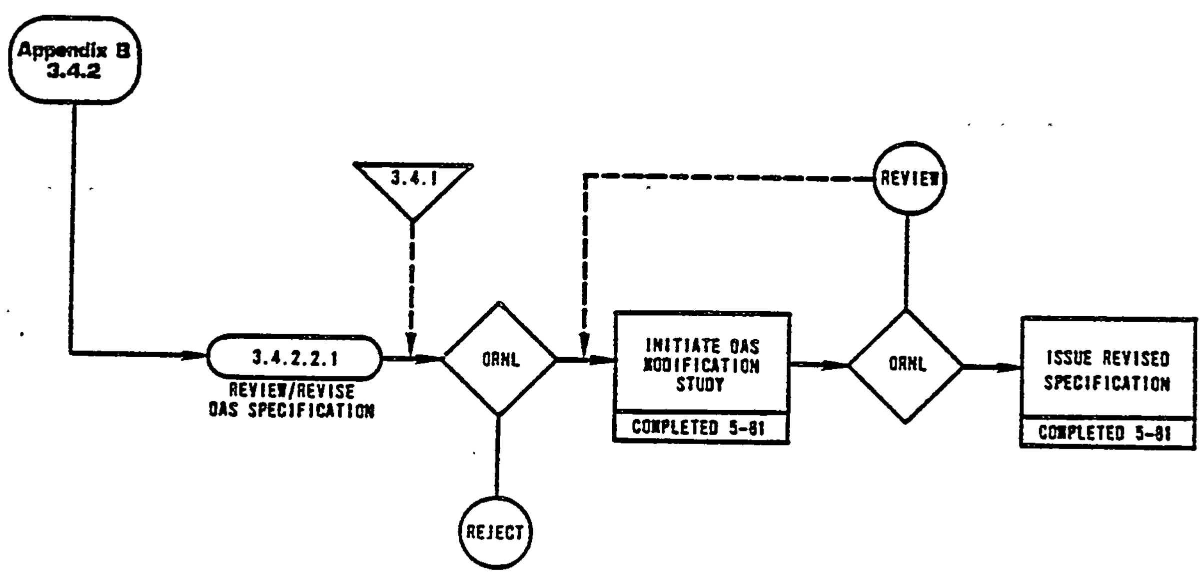


FIGURE 3.2-15 DECISION NETWORK - WOCC INTERFACE WITH DAS

3.2.4.13 Discharge Monitoring/Control Report Generation

Future regulations (such as R.G. 1.47) will require generation of numberous reports containing substantial data, calculated exposure, etc. These reports will require increased manpower to generate by hand.

ORNL DWG 81-23548

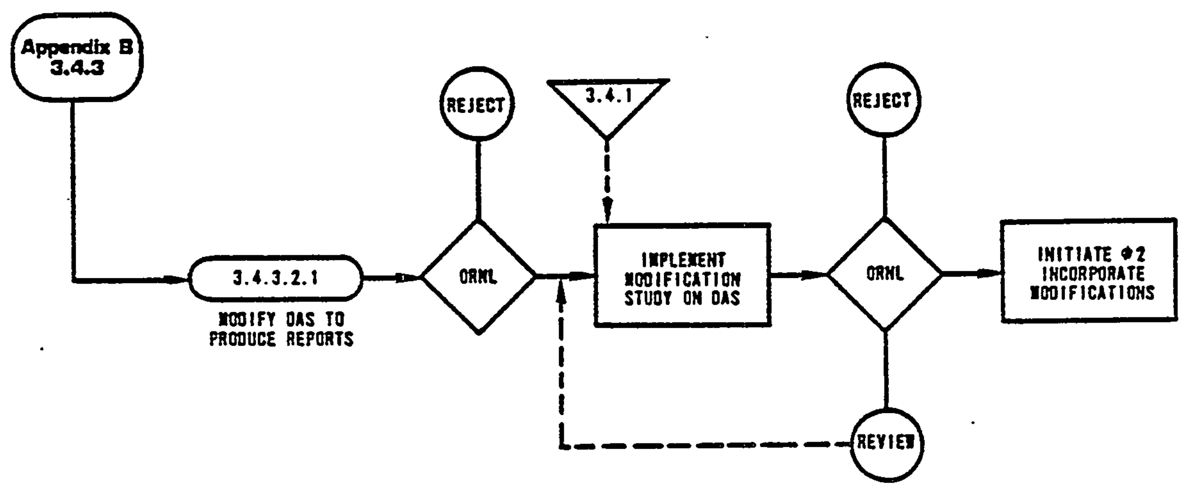


FIGURE 3.2-16 DECISION NETWORK - REPORT GENERATION

3.2.4.14 Discharge Monitoring/Control Miscellaneous Off-Gas Release Points

There are numerous local release points that are not monitored, making it difficult to demonstrate quantitatively that the total release from the site is in compliance with reporting requirements. Available data is not sufficient to determine the adequacy of monitoring/cleanup provisions for these miscellaneous points.

ORNL DWG 81-23549

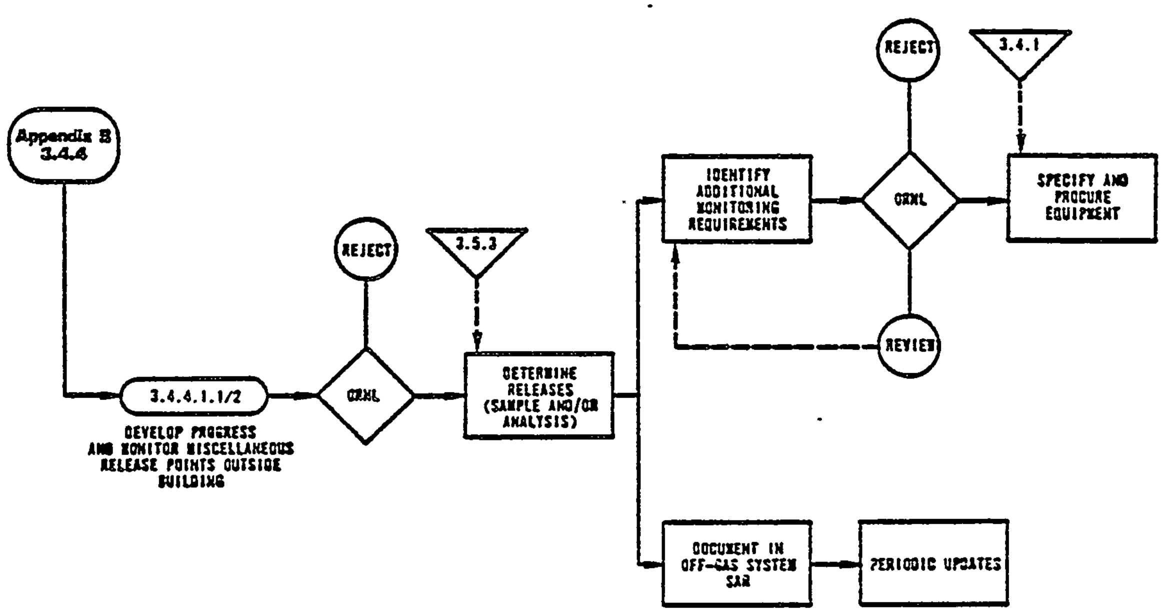


FIGURE 3.2-17 DECISION NETWORK - MISC. OFF-GAS RELEASE POINTS

3.2.4.15 General Waste Management Facilities Consolidation

Processing, storage and disposal facilities are widely separated. This increases the risk of personnel exposure and activity releases which are not consistent with ALARA philosophy. This arrangement has also led to increased capital, operating and maintenance costs.

ORNL DWG 81-23550

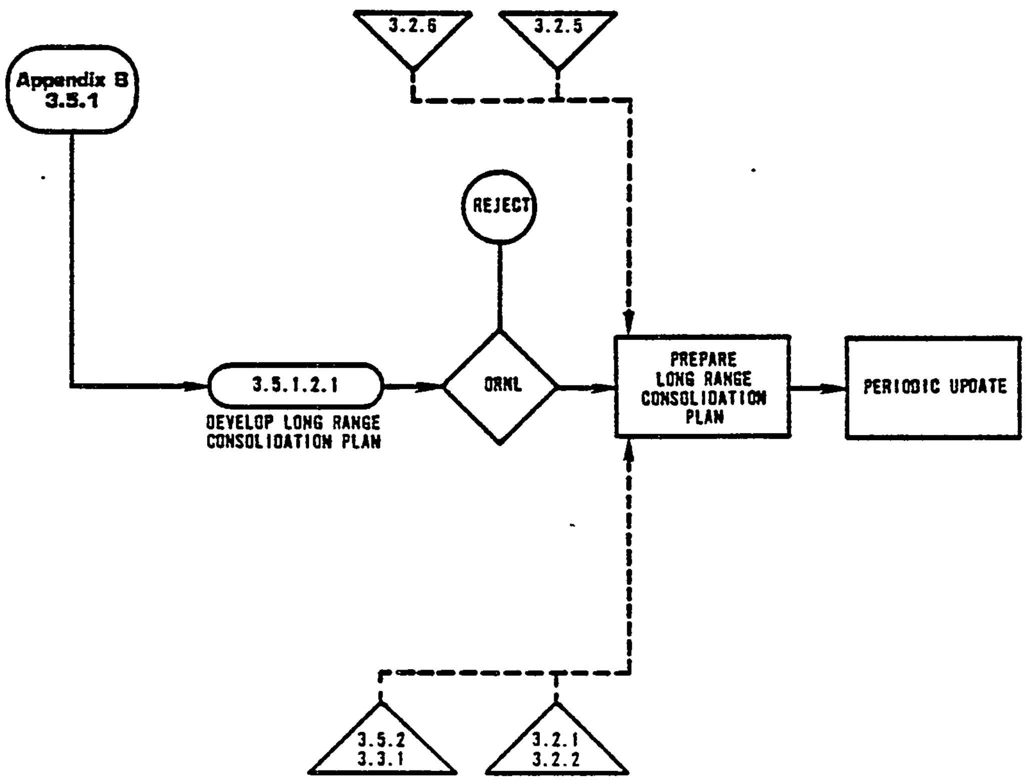


FIGURE 3.2-18 DECISION NETWORK - FACILITIES CONSOLIDATION

3.2.4.16 General Waste Management Interface with Future D&D Projects

Several D&D projects at ORNL have been planned by DOE. These activities would pose major packaging and handling difficulties for ORNL. They could adversely affect waste management as a result of additional personnel exposure, incompatibilty of wastes with process equipment, ground water or airborne activity releases while handling wastes, and increased demand on waste collection/processing/storage/disposal capabilities.

ORNL DWG 81-23551

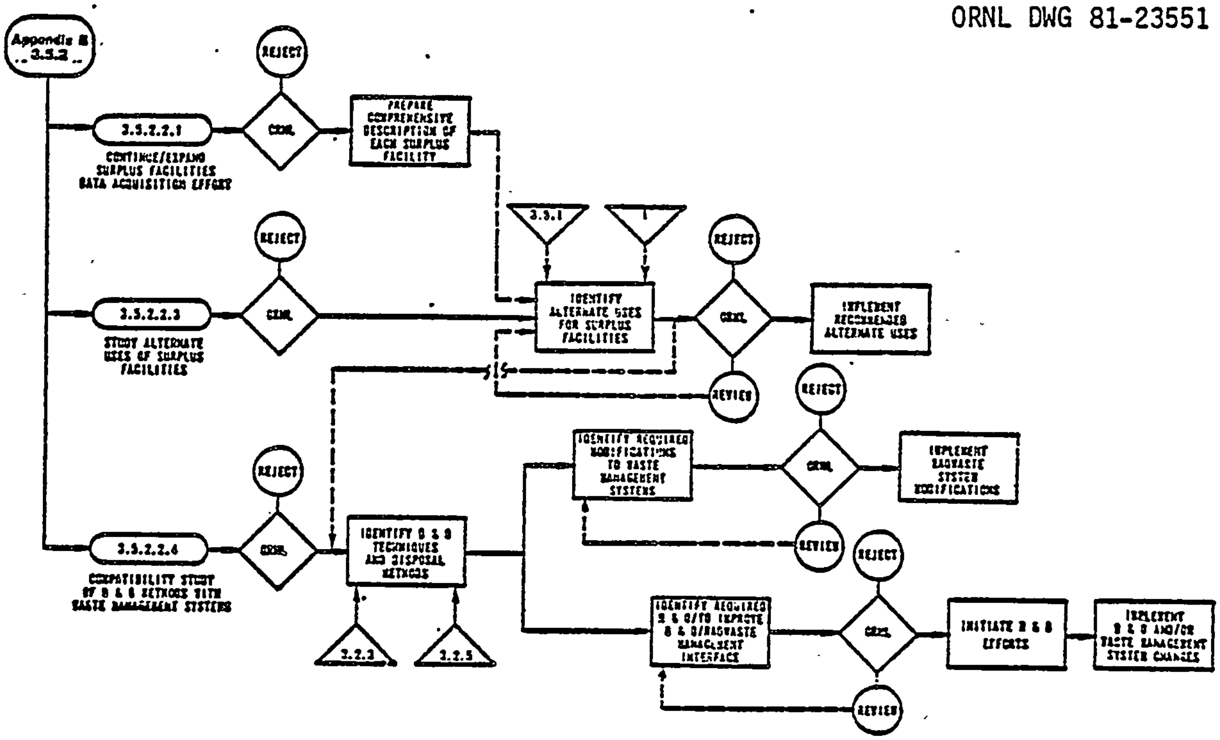


FIGURE 3.2-19 DECISION NETWORK - D&D PROJECT INTERFACE

3.2.4.17 General Waste Management
Waste Generator Interface

It is expected that waste processing costs will escalate as more stringent environmental regulations are enforced. The liquid waste collection system does not have the capability to monitor or control the waste quantity and type produced by each project (generator). This makes it difficult for waste management operations to process these wastes in the most cost-effective manner, or to associate these costs with a particular waste generator.

ORNL DWG 81-23552

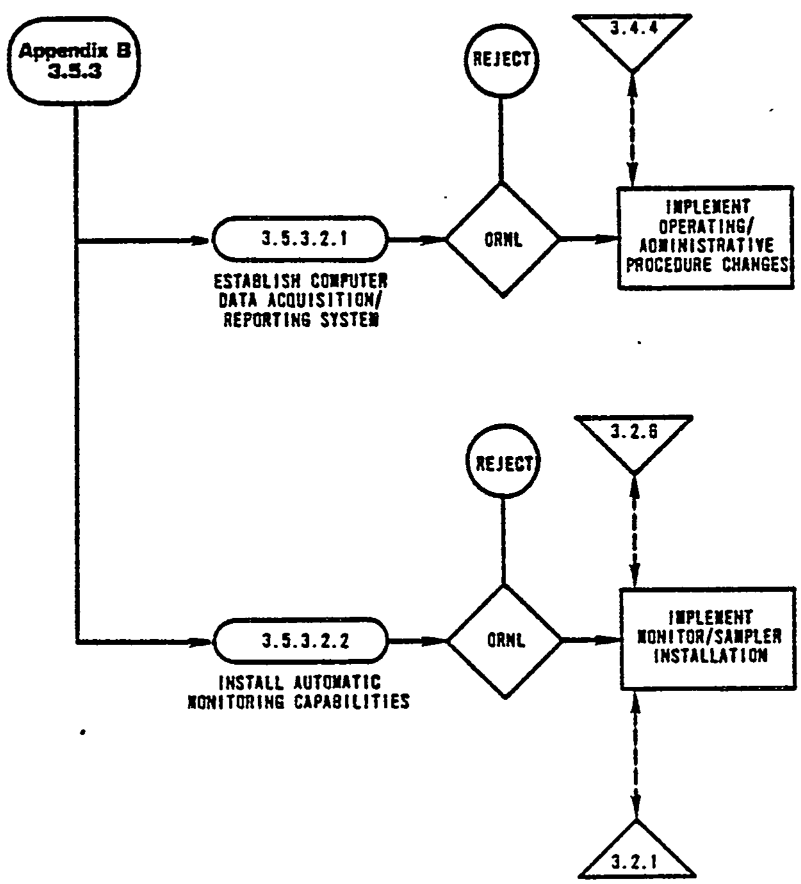
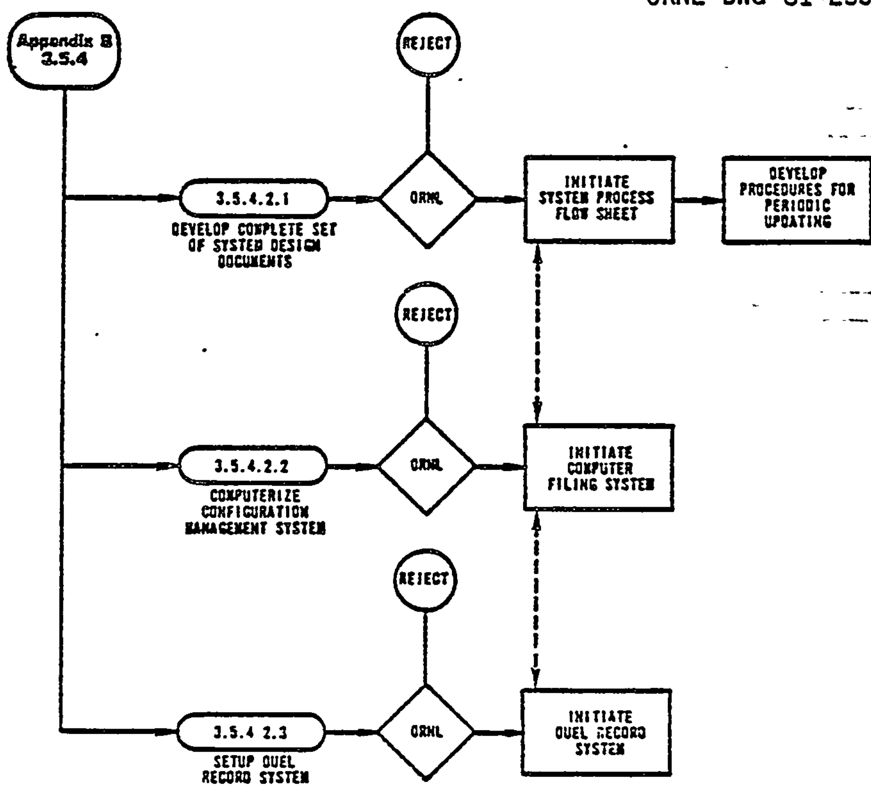


FIGURE 3.2-20 DECISION NETWORK - WASTE GENERATOR INTERFACE

3.2.4.18 General Waste Management Design Documentation (Configuration Management)

A necessary tool for managing the operation of the system is a complete system design information upon which decisions can be based. Design documents in some areas are inadequate for understanding how the system is designed, evaluating performance of the system, and assessing conformance of the system to current safety/regulatory practices. Documentation is at times inaccurate or incomplete. No standard format for presenting, recording, maintaining and updating documentation is available. Semiannual records keeping further complicates retrieval for review/revision.

ORNL DWG 81-23553



* SCHEDULE HOLD POINTS WHERE SYSTEM MODIFICATIONS ARE PLANNED OR EXPECTED

FIGURE 3.2-21 DECISION NETWORK - DESIGN DOCUMENTATION (CONFIGURATION MANAGEMENT)

3.2.4.19 General Waste Management
ALARA Program

Although quantitative ALARA guidelines are lacking for ORNL, certain conditions exist at ORNL which will make compliance with any that are developed more difficult. Obstacles to full compliance include: a) large volumes of waste; b) high activity levels of some wastes; c) physical separation between facilities; d) deteriorating condition of some older facilities; e) outmoded design of some older facilities; and f) expansion of non-nuclear R&D work in recent years.

ORNL DWG 81-23554

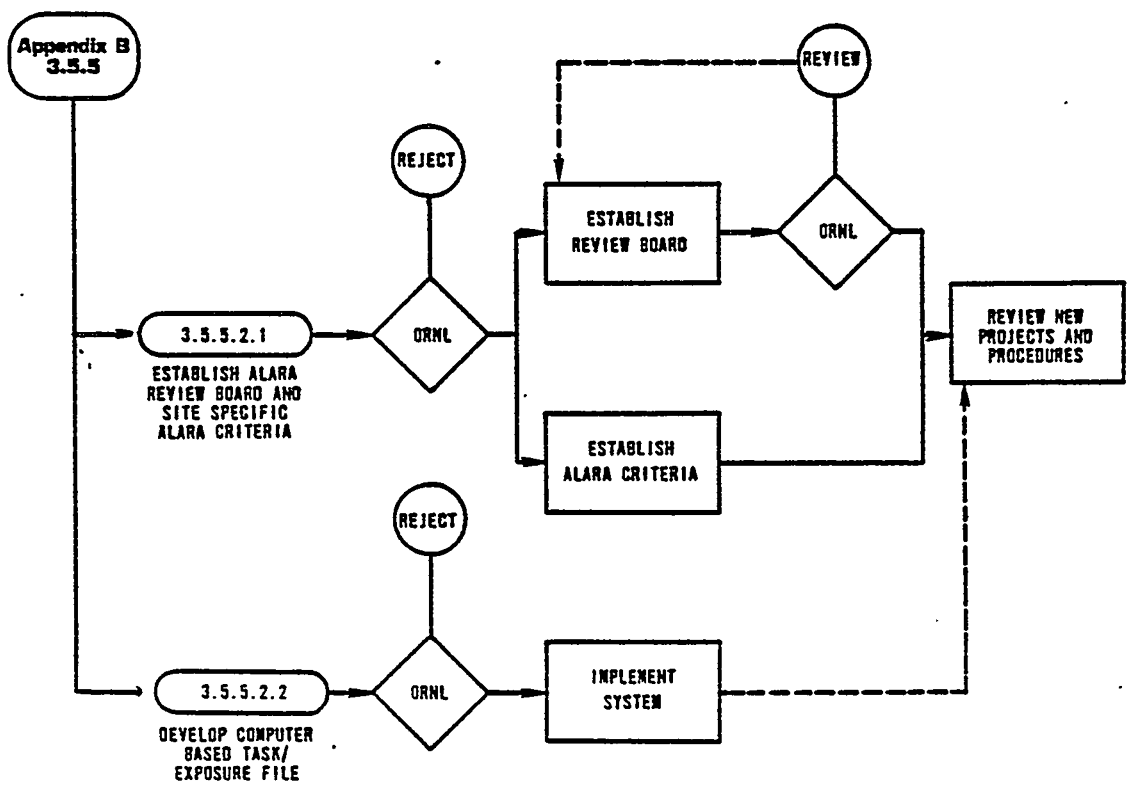


FIGURE 3.2-22 DECISION NETWORK - ALARA PROGRAM

3.3 IMPROVEMENT PROGRAM SCHEDULE

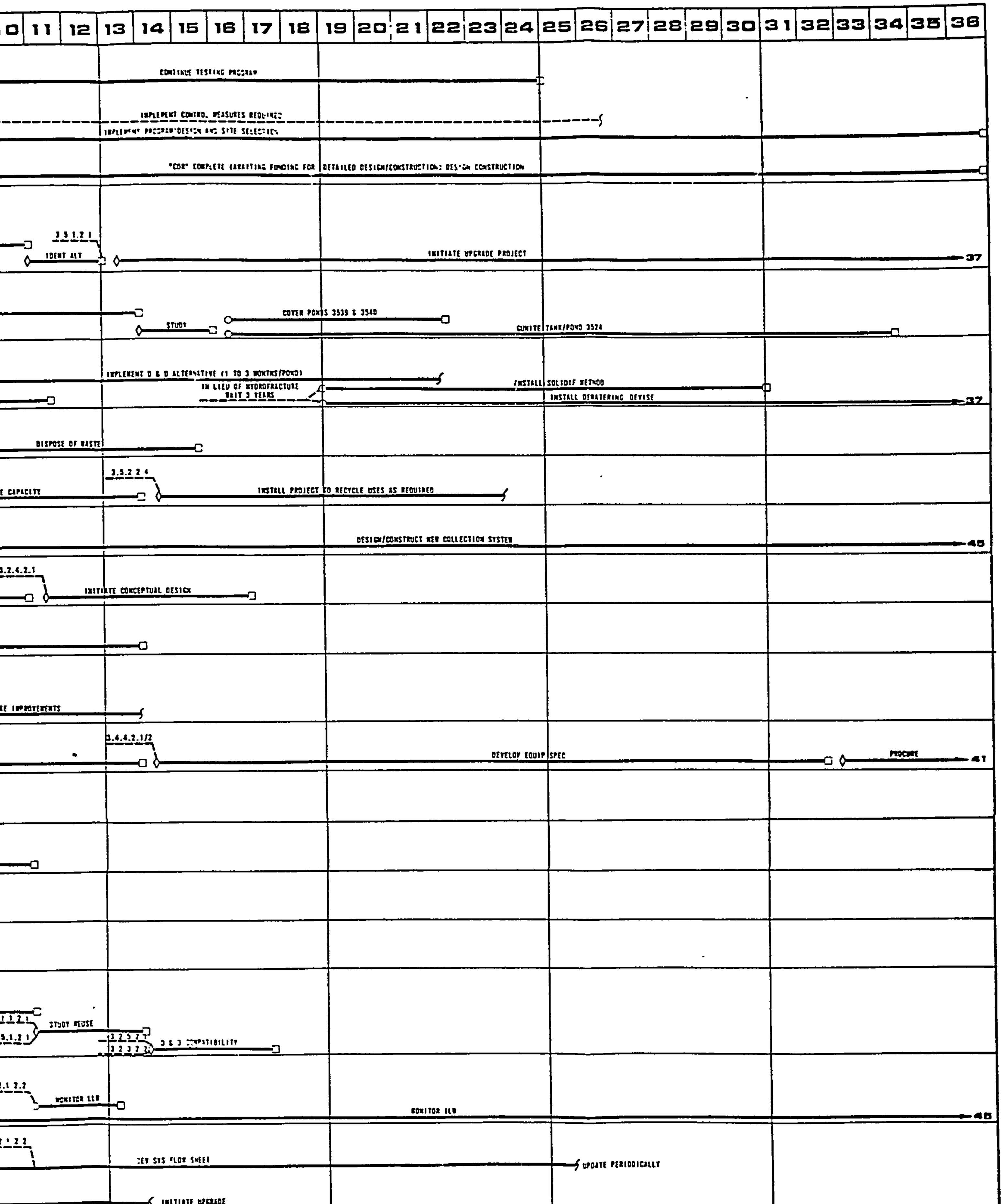
In Section 3.0 of Appendix B, preliminary scheduling information is presented and discussed for each recommended improvement project. In this section, a preliminary milestone schedule (Figure 3.3-1) is developed which shows the schedule duration and breakdown for major portions of each of these projects. Interdependencies between projects that were discussed in Appendix B are shown as dotted line constraints in Figure 3.3-1.

The time scale in Figure 3.3-1 is in months. Time durations for specific projects range from one to 48 months. No specific calendar years are associated with the start of any projects because of the preliminary nature of this planning effort and because of a lack of knowledge or control over other ORNL project plans, budget levels and manpower resources. For similar reasons, the starting point for all projects is the same. After the final selection of improvement projects and determination of priority levels, this schedule would be revised to show logical series relationships between projects. Further iterations would be made once expected annual funding and manpower levels have been established.

APPENDIX B	DESCRIPTION	PRIORITY	SCHEDULE (1 2 3 4 5 6 7 8 9)
3.1.1.	SOLID RADIOACTIVE WASTE MANAGEMENT SOLID LLW PROCESSING/DISPOSAL	I	
3.1.1.2.1	CONTINUE TESTING LEACHATE CONTROL MEASURES FOR BURIAL TRENCHES		
3.1.1.2.2	PROCEED WITH PLANS FOR EXPANDING GROUNDWATER MONITORING		3 1 1 2 1; EXPAND MONITORING OF EXISTING BURIAL GROUND
3.1.1.2.3	PROCEED WITH APPROPRIATE LEACHATE CONTROL MEASURES		3 1.1 2 2
3.1.1.2.4	PROCEED WITH MODIFIED SWDA-7 DESIGN PROGRAM		
3.1.1.2.5	CONDUCT DETAILED VR STUDY		CONDUCT STUDY AND DEVELOP VR ALTERNATIVES
3.1.1.2.7	PROCEED WITH JOINT VENTURE TO CONSTRUCT HAZARDOUS WASTE/LLW INCINERATOR		
3.2.1.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID LLW COLLECTION	III	
3.2.1.2.1	ANALIZE AND DOCUMENT EXISTING LLW SYSTEM		3 5.3.2 2; CONDUIT STUDY
3.2.1.2.2	PERFORM WATER BALANCE TEST		PERFORM WATER BALANCE
3.2.1.2.3	IDENTIFY/EVALUATE COLLECTION SYSTEM ALTERNATIVES		
3.2.2.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID LLW PROCESSING	III	
3.2.2.2.1	GATHER DATA AND MONITOR SURROUNDING ENVIRONMENT		GATHER DATA/MONITOR ENVIRONMEN
3.2.2.2.2	ENVIRONMENTAL IMPACT AND COST/BENEFIT OF ALTERNATIVES		
3.2.3.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID LLW SLUDGE DISPOSAL	I	3.5.2.2.4
3.2.3.2.1.	DISCONTINUE USE OF OPEN PITS		3.2.7.2.2; EVALUATE POND CONDITION
3.2.3.2.2	DATA COLLECTION/ENVIRONMENTAL SURVEY FOR EXISTING PITS		DEV ALTERN; PRELIMINARY DESIGN
3.2.4.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID LLW – CONTAMINATED OIL DISPOSAL	II	3.2.7.2.2; HYDROFRACTURE OR INCINERATOR ON LINE
3.2.4.2.1	CONTINUE TO STORE UNTIL ALTERNATIVE AVAILABLE		STOR UNTIL ALTERN AVAIL
3.2.5.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID LLW – DISCHARGE RECYCLE	III	
3.2.5.2.1	RECYCLE STUDY		STUDY; INSTALL S
3.2.6.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID ILW COLLECTION	I	3.2.1.2.3; 3.5.1.2.1; 3.5.3.2.2
3.2.6.2.1/2	STUDY UPGRADE ALTERNATIVES TO PROJECT IN CONCEPTUAL DESIGN		EVALUATE ALTERNATIVES
3.2.7.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID ILW SLUDGE DISPOSAL	I	3.5.1.2.1; 3.5.1.2.1
3.2.7.2.2	DEV ALTERNATIVE TO HYDROFRACTURE		EVALUATE ALTERNATIVES
3.2.8.	LIQUID RADIOACTIVE WASTE MANAGEMENT LIQUID HLW CLASSIFICATION	III	
3.2.8.2.1	DEVELOP QUANTATIV HLW DEFINITION AND CRITERIA		CONDUCT STUDY
3.3.1.	GASEOUS RADIOACTIVE WASTE MANAGEMENT COLLECTION DISCHARGE	I	INTERFACE W/ ONGOING PROJECT OCT 81
3.3.1.2.1	PERFORM ALARA REVIEW OF CURRENT UPGRADE PROJECT		ALARA REVIEW; 3.5.1.2.1
3.3.1.2.2	INSPECT REMAINING OFF-GAS STACKS AND BURIED DUCTS/PIPING		INSPECT; EVAL
3.4.1.	DISCHARGE MONITORING/CONTROL FRONT END DISCHARGE MONITORING EQUIPMENT	I	
3.4.1.2.1	REVIEW OPNL OPERATION AND SAR EXPRESS MONITORING REQUIRED		STUDY
3.4.2.	DISCHARGE MONITORING/CONTROL INTERFACE WITH DATA ACQUISITION SYSTEM	I	
3.4.2.2.1	REVIEW/REVISE DAS SPECIFICATION	III	COMPLETED 5-81
3.4.3.	DISCHARGE MONITORING/CONTROL – REPORT GENERATION	III	3.4.2.1
3.4.3.2.1	MODIFY DAS/AUTOMATIC REPORT GENERATION		DEVELOP AND IMPLEMENT SYSTEM
3.4.4.	DISCHARGE MONITORING/CONTROL MISCELLANEOUS OFF-GAS RELEASE POINTS	III	
3.4.4.2.1/2	DEVELOP PROGRESS AND MONITOR MISCELLANEOUS RELEASE POINTS OUTSIDE BUILDING		SURVEY SITE
3.5.1.	GENERAL WASTE MANAGEMENT FACILITIES CONSOLIDATION	III	
3.5.1.2.1	DEVELOP LONG RANGE CONSOLIDATION PLAN		LONG RANGE PLAN
3.5.2.	GENERAL WASTE MANAGEMENT INTERFACE WITH FUTURE D & D PROJECTS	I	
3.5.2.2.1	CONTINUE/EXPAND SURPLUS FACILITIES DATA ACQUISITION EFFORT		GATHER DATA ON FACILITIES
3.5.2.2.3	STUDY ALTERNATE USES OF SURPLUS FACILITIES		
3.5.2.2.4	COMPATIBILITY STUDY OF D & D METHODS WITH WASTE MANAGEMENT SYSTEMS		
3.5.3.	GENERAL WASTE MANAGEMENT WASTE GENERATOR INTERFACE	III	3 4 4 2 1/2
3.5.3.2.1	ESTABLISH COMPUTER DATA ACQUISITION/REPORTING SYSTEM		IMPLEMENT DATA ACQUISITION SYS
3.5.3.2.2	INSTALL AUTOMATIC MONITORING CAPABILITIES		3.2 6 2.1
3.5.4.	GENERAL WASTE MANAGEMENT DESIGN DOCUMENTATION	II	3.2.6 2 1
3.5.4.2.1	DEVELOP COMPLETE SET OF SYSTEM DESIGN DOCUMENTS		
3.5.4.2.2	COMPUTERIZE CONFIGURATION MANAGEMENT SYSTEM		COMPUTER FILING
3.5.4.2.3	SETUP DWEL RECORD SYSTEM		EVALUATE CURRENT SYSTEM

FIGURE

ORNL DWG 81-23595



3-1 PRELIMINARY MILESTONE SCHEDULE FOR RECOMMENDED IMPROVEMENT PROJECTS

4.0 COST ESTIMATES

4.1 COST ESTIMATING METHODOLOGY

The cost estimates in this study report are budgetary program cost estimates for the purpose of providing relative order-of-magnitude estimates for program planning purposes. Each of the recommended improvements is treated as a project, and is broken down to differentiate between Engineering, Capital Equipment and Construction. As more detailed project definition is developed, the cost estimates will be refined. A cost estimate code is used to identify the confidence level for the estimates in this report.

This report contains two types of cost estimates:

Code	Type of Cost Estimate
A	Planning Cost Estimáte (preconceptual)
B	Conceptual Design Cost Estimate (conceptual)

As used in this report, these are defined as follows:

- Planning Cost Estimate - budgetary estimate of total project costs which is developed during the early definition phase without benefit of design information. It is based on definition of the problem or mission, technology status and recommended technical approach. It may be based on a similar or comparative case. The planning cost estimates used in this report are accurate within 100 to 300 percent.

- Conceptual Design Cost Estimate - based on Conceptual design information, and is slightly more refined than the planning cost estimate. The conceptual design cost estimate as used in this report is accurate within 50 to 100 percent.

These two cost estimates and their definitions are consistent with UCC-ND Engineering Procedures EP-B-09 "Cost Estimating for Construction Projects." This procedure also defines several more highly refined cost estimates such as (C) Title I Design Cost Estimate and (D) Title II Design Cost Estimate. These are based on design information produced by the design phases of the projects. It is not expected that cost estimates in this report will be finer than conceptual since no design information is available for any of the recommended improvements.

4.2 IMPROVEMENT PROJECT COST ESTIMATES

The estimated costs of the recommended improvements are shown in the tabulation of Table 4.2-1. Each recommended improvement is treated as an individual improvement project. Each of these improvement projects are estimated without regard for economies which may be available through combining similar, or interfacing improvements. These considerations will be made as the work scope definitions and the conceptual schedules of the projects evolve. Each project is broken down into four broad scope categories: 1) Studies and Surveys, 2) Sitework, 3) Facilities, and 4) Equipment. The cost estimate confidence-level code defined in Subsection 4.1 is then assigned. Where information is available, the costs of these scope categories are further broken out as applicable by Engineering & Design, Capital Equipment & Materials, and Construction which includes installation of equipment. Engineering & Design are estimated in hours and 1981 dollars; Capital Equipment & Material and Construction are estimated in 1981 dollars.

TABLE 4.2-1

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.1.1.2.1	Corrections to Existing Burial Trenches						
	Studies & Surveys	A	200	10	10	30	50
	Sitework						
	Facilities						
	Equipment						
	Total						50
3.1.1.2.2a	Future SWSA Construction						
	Studies & Surveys	A	4,000	200			200
	Sitework	A	4,000	200	100	500	800
	Facilities						
	Equipment						
	Total						1,000
3.1.1.2.2b	VR Feasibility						
	Studies & Surveys	A	3,000	150			150
	Sitework						
	Facilities						
	Equipment						
	Total						150

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.1.1.2.2c	Centralized Incinerator						
	Studies & Surveys						
	Sitework						
	Facilities	A	50,000	2,500	6,000	6,500	15,000
	Equipment						
	Total						15,000
3.2.1.2.1	Survey LLW Collection System						
	Studies & Surveys	A	1,000	50			50
	Sitework						
	Facilities						
	Equipment						
	Total						50
3.2.1.2.2	LLW Collection System Water Balance						
	Studies & Surveys	A	1,000	50			50
	Sitework						
	Facilities						
	Equipment				15	35	50
	Total						100

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.2.1.2.3	LLW Collection System Corrections						
	Studies & Surveys	A	500	25			25
	Sitework						
	Facilities			135	640	800	1,575
	Equipment						
	Total						1,600
3.2.2.2.1	Survey LLW Collection Ponds						
	Studies & Surveys	A	500	25			25
	Sitework	A	2,000	100	50		150
	Facilities						
	Equipment						
	Total						175
3.2.2.2.2	Line/Cover LLW Collection Ponds						
	Studies & Surveys	A	500	25			25
	Sitework					20	20
	Facilities	A		35	127	168	330
	Equipment						
	Total						375

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.2.3.2.1	Decommission LLW Sludge Disposal Pits						
	Studies & Surveys	A	2,000	100		50	150
	Sitework					(1)	
	Facilities						
	Equipment						
	Total						150 (Survey Only)
3.2.3.2.2	Alternative LLW Sludge Disposal Method						
	Studies & Surveys	A	2,000	100			100
	Sitework						
	Facilities						
	Equipment	A			750		750
	Total						850
3.2.4.2.1	Contaminated Oil Via Hydrofracture Facility						
	Studies & Surveys						
	Sitework						
	Facilities						
	Equipment						
	Total	A					10(2)

Notes:

1. Decommission cost for each pond ranges from $35,000 to $750,000. Outcome of survey required to estimate project cost for decommissioning all pits.

2. Operating cost for disposal of current inventory.

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. Hours	& Design Dollars	Capital	Constr.	Total
3.2.5.2.1	Processed LLW Recycle Study						
	Studies & Surveys	A	1,000	50			50
	Sitework						
	Facilities						
	Equipment						
	Total						50
3.2.5.2.2	Recycle Water Storage Distribution						
	Studies & Surveys						
	Sitework						
	Facilities (1)	A	200	10	50	40	100
	Equipment						
	Total						100
3.2.6.2.1	Replace ILW Tanks and Pressurized Drain Lines						
	Studies & Surveys						
	Sitework						
	Facilities	B	60,000	3,913	4,435	6,652	15,000
	Equipment						
	Total						15,000

Notes

1. For new reservoir. Use of gunite tanks would require less expenditure. Cost of distribution system cannot be determined without more information on reuses.

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.2.6.2.2	Consolidated ILW Tanks and Replace Gravity Drain Lines						
	Studies & Surveys						
	Sitework						
	Facilities	A	50,000	2,500	3,000	4,500	10,000
	Equipment						
	Total						10,000
3.2.6.2.3	Alternative ILW Replacement Schemes						
	Studies & Surveys	A	2,000	100			100
	Sitework	A				50	50
	Facilities						
	Equipment						
	Total						150
3.2.7.2.2	Design Alternate ILW Solidification Scheme (1)						
	Studies & Surveys	A	5,000	250			250
	Sitework						
	Facilities						
	Equipment						
	Total						250

Notes:

1. May be worked in conjunction with 3.2.3.2.2.

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.2.8.2	Development of HLW Classification System						
	Studies & Surveys	A	10,000	500			500
	Sitework						
	Facilities						
	Equipment						
	Total						500
3.3.1.2.1	GRW System Upgrade						
	Studies & Surveys	A	1,000	50			50
	Sitework	B				1,025	1,025
	Facilities	B		1,394	1,712	2,569	5,675
	Equipment						
	Total						6,750
3.3.1.2.2	Survey GRW Collection System						
	Studies & Surveys	A	2,000	100			100
	Sitework						
	Facilities						
	Equipment						
	Total						100

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.4.1.2.1	Specifications for Improved Monitoring Equipment						
	Studies & Surveys	A	2,000	100			100
	Sitework						
	Facilities						
	Equipment						
	Total						100
3.4.1.2.2	Replacement of Front-End Radiation Monitors						
	Studies & Surveys						
	Sitework						
	Facilities						
	Equipment	A					1,250
	Total						1,250(1)
3.4.3.2	Incorporate Report Generation Capability						
	Studies & Surveys	A	1,000	50			50
	Sitework						
	Facilities						
	Equipment						
	Total						50

Notes:

1. Budgetary figure. Results of evaluations in 3.4.1.2.1 are needed to determine replacement costs more accurately.

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.4.4.2.1	Improve Monitoring/ Reporting of Local Releases						
	Studies & Surveys	A	2,000	100			100
	Sitework						
	Facilities						
	Equipment						
	Total						100
3.4.4.2.2	Additional Monitors for Local Releases						
	Studies & Surveys						
	Sitework						
	Facilities						
	Equipment	A					25/unit
	Total						(1)
3.5.1.2	Facilities Consolidation Plan						
	Studies & Surveys	A	2,000	100			100
	Sitework						
	Facilities						
	Equipment						
	Total						100

Notes

1. Total cost of additional monitors is dependent on outcome of study in 3.4.4.2.1.

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.5.2.2.1	D&D Project Data Acquisition						
	Studies & Surveys	A	6,000	300			300
	Sitework						
	Facilities						
	Equipment						
	Total						300
3.5.2.2.3	Alternate Reuses of Surplus Facilities						
	Studies & Surveys	A	2,500	125			125
	Sitework						
	Facilities						
	Equipment						
	Total						125
3.5.2.2.4	Impact of D&D on Radwaste Facilities						
	Studies & Surveys	A	1,500	75			75
	Sitework						
	Facilities						
	Equipment						
	Total						75

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.5.3.2.1	Data Acquisition System for Waste Inputs						
	Studies & Surveys						
	Sitework						
	Facilities	A	3,000	150	-	-	150
	Equipment						
	Total						150
3.5.4.2.1	Upgrade Existing Design Documentation						
	Studies & Surveys						
	Sitework						
	Facilities	A	6,000	300			300
	Equipment						
	Total						300
3.5.4.2.2	Computerize Design Documentation System						
	Studies & Surveys						
	Sitework						
	Facilities	A	4,000	200			200
	Equipment						
	Total						200

TABLE 4.2-1 (Cont'd)

ORNL RADWASTE MANAGEMENT PROGRAM
IMPROVEMENT PROJECTS COST ESTIMATES ($K)

Reference Subsection Appendix B	Project Title	Est. Code	Engrg. & Design Hours	Engrg. & Design Dollars	Capital	Constr.	Total
3.5.4.2.3	Set Up Dual Record Keeping System						
	Studies & Surveys	A	1,000	50			50
	Sitework						
	Facilities						(1)
	Equipment						
	Total						50
					TOTAL COST OF IMPROVED PROJECTS		60,000

Note:

1. Follow-on duplication of records cannot be estimated until completion of survey of existing records.

APPENDIX A

DESCRIPTION OF EXISTING RADWASTE MANAGEMENT PRACTICES/FACILITIES

The major sources of radioactive waste, existing process facilities, and current operating practices for managing and controlling liquid, solid, and gaseous waste products are described in this Appendix. The purpose of this Appendix is to present a general descriptive background or data base for ORNL's radioactive waste management operations so that a better appreciation can be gained for the suggested improvement projects presented in Section 3.0 of Appendix B. The following is a brief discussion of the salient features of the present ORNL radwaste management operation. Detailed descriptions are provided in the referenced documentation.

1.0 WASTE GENERATING PROCESSES AND RELEASES

1.1 GENERAL

ORNL generates radioactive waste in solid, liquid and gaseous form. In comparison to a commercial nuclear power plant facility, relatively large amounts are produced in each of these categories as listed in Table A.1-1. For each of these categories, there are also a large number of generators located in many different areas and producing wastes of widely varied content. In most cases, the only available information on waste quantities and characteristics is for a mixture of waste generated in a particular area or facility. Detailed qualitative and quantitative information is readily available for specific waste generator.

1.2 CURRENT MAJOR SRW GENERATORS

SRW is classified by physical characteristics, by type of contamination and by the extent of contamination. For purposes of handling and storage, there are three basic categories of SRW, defined (Binford and Gissel, 1975) as follows:

- Transuranic Waste (TRU) - contains more than 10 μCi/kg of certain alpha emitting radionuclides of long half-life, including U-233, Plutonium, and transplutonium nuclides. These wastes are primarily a result of activities in the TRU processing facility and fuel reprocessing operations. Because of storage requirements, they are further classified as combustible or non-combustible. In most instances, these wastes also have beta-gamma activity associated with them, and in some cases, neutrons are present as a result of spontaneous fission.

- U-235 Waste - waste that contains one-gram or more of fissionable material regardless of concentration, or more than one-gram/ft^3 of the same material, regardless of quantity. Primarily this consists of U-235 contaminated material originating from various metallurgical operations, residues from instrument applications, hot cell applications and various research and analytical activities.

- General SRW - all solid waste not included in the previous two categories. This waste contains beta-gamma and/or non-fissile alpha activity and originates in many locations within the laboratory complex. By far, this category contains the bulk of the waste generated at the laboratory. For handling purposes, this waste category is further divided into "low-level" waste (<200 mr/hr on contact) and "high-level" waste (>200 mr/hr on contact). The low level part is segregated still further into compactible and non-compactible portions.

The solid radwaste in each of the above categories varies widely in physical makeup. The largest volume is "laboratory trash," consisting of glassware, paper, rags and similar materials. Other contributors include process wastes (filters, spent ion exchange resins, etc.), contaminated equipment items (tanks, piping, valves, instruments, etc.) and contaminated soil or building materials resulting from process leaks or spills. A breakdown for general category SRW produced at ORNL is listed in Table A.1-2. The average composition for the combustible portion of this waste category is given in Table A.1-3. Current and projected volumes and activity content for retrievably stored SRW produced at ORNL are presented in Tables A.1-4 and A.1-5, respectively.

1.3 CURRENT MAJOR LRW GENERATORS

LRW is classified by activity level and by source for purposes of collection, processing and disposal. There are four principal categories of liquid waste generated at ORNL. These are high-level, intermediate level, low-level and transuranic wastes. The sources for each of these categories are described below:

High level waste - defined in DOE manual as the aqueous waste resulting from the operation of the first-cycle extraction system, or equivalent concentrated wastes from subsequent extraction cycles, or equivalent wastes from a process not using solvent extraction in a facility for processing irradiated reactor fuels. The principal sources of HLW at ORNL are the Pilot Plant (Building 3019), the Fission Product Development Laboratory (Building 3517) and the Transuranium Facility. Very little HLW has been generated at ORNL in the past and none is being produced currently. At present there are several thousand gallons of "high level" transuranic waste stored in underground tanks adjacent to Building 2531.

Intermediate level waste - This designation is an informal one used at ORNL to categorize low-level liquid wastes which are segregated for processing purposes. These wastes consists of "hot" sinks and other process drains from R&D laboratories, pilot plants and research reactors. There is no rigorous definition of ILW; however, it is generally agreed that the upper limit on beta-gamma activity level for ILW is 5.3 Ci/liter. The average activity level in the ILW after collection and intermixing is about 8 mCi/liter.

The major radionuclides present in the ILW are Sr-90 and Cs-137, with lesser amounts of Co-60, Ru-106 and various rare earths. The ILW contains small amounts of organic material but consists primarily of aqueous waste solutions. As generated, these wastes are usually nitrate solutions, but in the intermediate collection tanks, sodium hydroxide is added to neutralize any acidic conditions. Therefore, when these wastes reach the ILW processing system, they are normally a mixture of dilute sodium hydroxide and sodium nitrate. Together, these compounds account for 75 percent of the total chemical content of the dilute ILW. Total solids concentration in the dilute ILW ranges from 5,000 to 10,000 ppm.

Over the past 10 years, an average yearly volume of 7.2×10^6 liters of liquid ILW has been generated. Typical volumes, activity levels and chemical constituents for the major liquid ILW contributors are listed in Tables A.1-6 and A.1-7.

Most ILW is in liquid form. However, there is also a substantial amount of ILW sludge that precipitates out of the liquid ILW before this waste stream leaves the intermediate collection tanks ahead of the ILW evaporator facility. Currently, there are approximately 1.2×10^6 liters of this sludge stored in the gunite storage tanks. An additional 3.8×10^4 liters of sludge are produced each year. Typical chemical and radiological characteristics for this sludge are listed in Table A.1-8.

Low-level waste - consists primarily of drains that are normally not radioactive, such as floor washdown, steam condensate and process vessel cooling water. The only LLW streams that are normally radioactive are distillate from the ILW evaporator and runoff from certain contaminated areas such as the ILW collection/storage tank farms. A large portion of the total LLW input volume is unwanted rainwater and groundwater intrusion.

As in the case of HLW and ILW, the individual sources of LLW are normally not monitored or sampled. However, as shown in Figures A.2-3 and A.2-4, flow and activity monitors are provided in the LLW drain headers leading from major areas of the laboratory to the LLW processing system. For each of these areas, Table A.1-9 presents the average yearly volume and activity level of waste water collected during the past ten years. Over this reporting period, ORNL has produced, on the average, 6.3×10^5 liter/day of LLW, containing 6.5×10^{-5} μCi/cc of gross beta activity. The portion of this activity released to the environment after processing is indicated in Figures A.1-1 and A.1-2. The chemical makeup of this waste, after intermixing, is typically as listed in Table A.1-10.

Transuranic waste - consists primarily of process drains from the transuranic process area (7900 Area). By definition, TRU waste is that which contains or is assumed to contain more than 10 μCi/kg of alpha-emitting, long half-lived and highly radiotoxic transuranium elements (i.e., elements above uranium in the periodic table having atomic numbers greater than 92). The radionuclides included are U-233 (with its daughter products), plutonium, and transplutonium nuclides except Pu-238 and Pu-241 (Pu-238 and Pu-241 should be handled as transuranium-contaminated waste when so indicated by PU-239 impurities or when required by local burial criteria). The rate of TRU waste generation has varied from 38,000 to 212,000 liter/yr. This waste type is administratively segregated in the transuranium process area and then drained to a new doubly contained 38,000 liter tank (W-20). Although segregated in this manner for collection and sampling, it is eventually pumped to the ILW evaporator feed tanks, where it is diluted by other ILW feed streams and loses its identity as TRU waste.

1.4 CURRENT MAJOR GRW GENERATORS

GRW is classified by activity level, quantity and source for purposes of collection and processing prior to disposal. The three principal categories of GRW are hot off gas, cell ventilation and alpha enclosure ventilation.

- Hot off gas - low flow gaseous exhaust from primary work spaces where radioactive emission would normally be expected, such as tanks, evaporators and other process vessels.

- Cell ventilation - high flow gaseous exhaust from large volume, limited access areas such as hot cells, equipment cubicles and other containment zones. Normally, little or no activity is expected in this waste stream.

- Alpha enclosure ventilation - intermittent exhaust from enclosed work spaces such as glove boxes, where highly toxic alpha emitters are handled.

GRW generators are located in many areas of the laboratory complex. Depending on their location, they are either vented locally or sent to central facilities for processing and disposal. Little data is available for locally vented gaseous waste. For the waste processed centrally, sample data is collected and reported regularly, but only after intermixing of all waste contributors. A summary of the total reported releases from the site for the past 20 years is listed in Table A.1-11. Typical annual quantities of activity discharged from each major release point are listed in Table A.1-12.

1.5 FUTURE RADWASTE GENERATORS

Over the next 20 years, it is not anticipated that the amount of radioactive waste produced by R&D work and pilot plant projects will vary greatly from what is currently being produced. When sizing the new hydrofracture facility, it was assumed that there would be some new pilot plant projects in the future that would produce an estimated 18,900 liters of waste per year. The activity level of this hypothetical waste stream was conservatively assumed to be 8.5 Ci/liters. A detailed breakdown of radionuclides in this waste stream is given in Table A.1-13.

Over the next 10 to 20 years, additional waste will also be produced by planned D&D projects, although the radionuclides contained in this future waste will consist of "old" radionuclides (in that this activity is already in existence and is merely being transferred/transformed from one location or physical form to another location or physical form.) One such D&D waste stream that is well defined is the gunite tank sludge discussed previously. Another is the sludge in Settling Basin 3513, which contains approximately 3,200 m^3 of sludge having a bulk density of 1.2 gm/cc. Activity concentrations for these waste streams are given in Table A.1-13.

Additional D&D wastes will be generated as a result of DOE's surplus facilities decommissioning program. Quantities and characteristics for these wastes are not well defined as yet. Preliminary SRW volume estimates are given in Table A.1-14.

TABLE A.1-1 COMPARISON OF ORNL WASTE QUANTITIES WITH THOSE OF TYPICAL 1000 MWe, LIGHT WATER REACTORS

WASTE CATEGORY	ORNL		BWR		PWR	
	M^3/yr	Ci/yr	M^3/yr	Ci/yr	M^3/yr	Ci/yr
SOLID WASTE (1)(2)(4)	3,000	20,000	1,500	8,000	500	2,000
LIQUID WASTE (3) (Before Processing)	240,000	44,000	40,000	1,400	7,600	200
GASEOUS (5)		67,000	-	4×10^6	-	200

NOTES:

1. Solid waste is volume as shipped for commercial sites and as disposed of for ORNL. Because some portions of the solid waste are a result of processing liquid wastes, a portion of the reported activity is repeated under liquid wastes.

2. Solid waste quantities for BWR/PWR's are averages for operating plants, pro-rated to 3400 MWt and 80 percent plant availability factor (Phillips and Gaul, 1977).

3. Liquid waste quantities for BWR's are derived from ANSI-N197. Those for PWR's are derived from ANSI-N199. ORNL liquid waste quantities are average values derived from Tables A.1-6 and A.1-9.

4. Solid waste quantities for ORNL are ten year averages for amount buried or stored between 1969 and 1978 (see Table A.3-1). During this period the stored or buried corresponds to the amount generated since no volume reduction (i.e. compaction) was practiced on solid waste generated during that time span.

5. ORNL gaseous waste quantities are average values derived from Table A.1-11. Those for BWR/PWR's are averages for operating plants, pro-rated to 3400 MWt (Blomeke and Harrington, 1968).

TABLE A.1-2 ANALYSIS OF GENERAL CATEGORY SRW PRODUCED AT ORNL[1]

	VOLUME (M^3/yr)		ACTIVITY (Ci/M^3)	
DESCRIPTION	<200 Mr/hr	>200 Mr/hr	<200 Mr/hr	>200 Mr/hr
Combustible	425	70	.016	35.3
Noncombustible		170		11.8
a. Metal	570	-	.64	-
b. Glass	60	-	.64	-
Other noncombustible (soil, concrete, bldg. rubble, etc.)	595	-	.67	-
Other innocuous waste	110	-	Negligible	-
Subtotals	1,760	240	0.45 (avg)	19 (avg)

TOTAL VOLUME = 2,000 M^3/yr

AVERAGE TOTAL ACTIVITY = 2.7 Ci/M^3

NOTES:

1. Figures are average values derived from Dumont, 1980.

TABLE A.1-3 AVERAGE COMPOSITION OF GENERAL CATEGORY COMBUSTIBLE SRW[2]

PERCENT OF TOTAL VOLUME	COMPOSITION[1]
75	Paper and cloth (shirts, coveralls, cotton mop heads, etc.)
20	Plastic (assumed to be PVC requiring off-gas removal of chlorides)
3	Rubber (stoppers and tubing), leather (shoes) and wood (filter frames, etc.)
1	Metal (nails, buttons, snaps and zippers)
≤1	Glass (bottles, tubing and lab ware)
<1	Organic liquid and other miscellaneous materials

NOTES:

1. Bulk density ranges from 0.054 to 0.082 gm/cc.
2. Values taken from Stang, 1980.

TABLE A.1-4 CURRENT AND PROJECTED VOLUMES OF RETRIEVABLE TRU WASTE[3]

Storage Type	Volume of Waste Stored Through 1979 as Reported in SWIMS		Adjusted Volume of Waste Stored Through 1979		Projected Volume of Stored Waste in 1995[1]	
	Combustible (m^3)	Noncombustible (m^3)	Combustible (m^3)	Noncombustible (m^3)	Combustibel (m^3)	Noncombustible (m^3)
Drums	192	158	192	158	480	400
Buried Casks	208	322	115[2]	177[2]	115	177
Stored Casks	0	0	0	0	170	270
Lined Wells	0.3	2.6	0.3	2.6	0.1	6.5

NOTES:

1. Projections are based on adjusted volumes.

2. Volume data listed in SWIMS files is total of physical volume of waste plus volume of container material. Breakdown of this total into combustible and noncombustible fractions in computer files does not reflect noncombustible nature of storage containers. Prior to projecting data for concrete casks, concrete volume was subtracted from totals. This volume number was adjusted using combustible/noncombustible fractions determined from computer files.

3. Values taken from Ellis, 1980.

TABLE A.1.5 CURRENT AND PROJECTED ACTIVITY OF DOSE SIGNIFICANT ISOTOPES IN RETRIEVABLE TRU WASTE[2]

Storage Type	Isotope	Activity Stored Through 1979 (Ci)	Projected Activity Stored in 1995 (Ci)
Drums	Am-241	1.137E + 04[1]	2.8E + 04
	Cf-252	2.800E + 05	1.1E + 05
	Cm-244	2.117E + 05	3.4E + 05
	Pu-238	7.766E + 03	1.8E + 04
	Pu-239	1.508E + 02	3.8E + 02
	Pu-240	1.153E + 02	8.0E + 02
Buried Casks	Cf-252	6.672E + 04	1.3E + 03
	Cm-244	1.279E + 05	5.9E + 04
	Pu-239	1.230E + 01	1.2E + 01
	Pu-240	-	1.8E + 02
Stored Casks	Cf-252	-	2.5E + 04
	Cm-244	-	1.4E + 05
	Pu-239	-	1.9E + 01
	Pu-240	-	1.4E + 02
Lined Wells	Cm-244	5.08E + 02	8.1E + 02
	Pu-239	2.20E + 01	5.5E + 01
	Pu-240	-	1.2

NOTES:

1. 1.137E + 04 same as 1.137×10^4
2. Values taken from Ellis, 1980.

TABLE A.1-6 PRINCIPAL LIQUID ILW SOURCE VOLUMES/ACTIVITIES[1]

SOURCE	VOLUME (liter/yr)	ACTIVITY (Ci/liter)[2]
Chemical Separation Facility (Bldg 3019)	962,500	-
Fission Product Development Lab	317,900	-
ORR & BSR	929,600	-
High Flux Isotope Reactor	806,200	-
Radioisotope Area	538,600	0.026 (Max.)
Research Lab (Bldg 4500)	544,700	-
Transuranium Facility	141,600	<1.32 (Max.)
Bldg 3026C (Radioisotope)	26,500	-
Bldg 3026D (Hot Cells)	60,200	-
Cell Ventilation Duct (Bldg 3500)	135,900	-
Bldg 3525 (Hot Cells)	241,500	-
Hot Off-gas Duct Condensate	20,100	-
Bldgs. 3503, 3508 and Chem. Tech	20,100	-
All Other Sources	708,800	-
Total	5,454,200	0.008

NOTES:

1. Valves shown are those reported in calendar year 1976 (Binford and Orfi, 1978).
2. Activity data not available for sources other than radioisotope area and transuranium facility.

TABLE A.1-7 TYPICAL COMPOSITION OF LIQUID ILW[1]

CHEMICAL/RADIONUCLIDE	CONCENTRATION MOLES/LITER	CONCENTRATION µCi/liter
NaOH	0.22	-
$NaNO_3$	0.32	-
Na_2SO_4	0.04	-
$Al\ (NO_3)_3$	0.02	-
NH_4NO_3	0.2	-
NaCl	0.006	-
Co-60	-	2.8×10^{-3}
Sr-90	-	6.5×10^{-1}
Zr-95/Nb-95	-	8.3×10^{-1}
Ru-106	-	2.9×10^{-3}
Cs-137	-	5.9×10^{-4}
Ce-144	-	3.5×10^{-7}

NOTE:

1. Composition after collection, pH adjustment and intermixing of all sources (De Laguna, 1968).

TABLE A.1-8 COMPOSITION OF ILW COLLECTION TANK SLUDGE[1]

ELEMENT[2]	WT %	μCi/cc
U	1.5 to 22.9	-
Th	0.8 to 14.2	-
Al	1.0 to 10.3	-
Ca	2.9 to 10.3	-
Fe	1.0 to 18.5	-
Pb	Neg. to 4.0	-
S	Neg. to 3.7	-
P	Neg. to 1.7	-
Cl	0.7 to 2.7	-
Na	Small	-
Sr-90	Small	400 to 660
Cs-137	Small	50 to 75
Cm-244	Small	10
Pu-239	Small	0.2 to 0.3
Density	2.0 gm/cc	

NOTES:

1. Composition is an average based on samples from sludge now in gunite tanks collected over past 35 years (Ehrlich and Weeren, 1979). Depending on nature of current R&D programs, sludge produced today can vary considerably from this norm.

2. List of elements contained in sludge is not complete. Method of analysis used did not detect hydrogen, nitrogen, carbon or oxygen.

TABLE A.1-9 SUMMARY OF LOW LEVEL WASTE SOURCE ACTIVITIES/VOLUMES (3)

ACTIVITY (mCi)

	1970 Gross-Beta	1971 Gross-Beta 8 Mon. Avg.	1971 Sr-90 10 Mon. Avg.	1972 Sr-90	1973 Gross-Beta 11 Mon. Avg.	1974 Gross-Beta	1975 Gross-Beta	1976 Gross-Beta	1977 Gross-Beta	1978 Gross-Beta 5 Mon. Avg.	1978 Sr-90 7 Mon. Avg.	1979 Sr-90 6 Mon. Avg.	10 yr Gross-Beta Avg. (2)	10 yr Avg. % of Total
Area (MH234)	305.0	277.5	105.0	47.5	55.5	40.0	90.0	61.4	27.7	21.0	24.0	12.3	93.8	7.7
Area (MH114 - MH112)	-	-	357.5	334.2	225.0	225.0	215.8	358.8	315.5	305.2	158.3	313.2	297.9	24.3
MH112	570.8	936.3	306.0	10.0	16.4	44.2	23.2	8.1	5.3	7.6	1.3	3.2	162.5	13.3
Bldg. 3501 - 3508	35.5	45.0	21.0	43.3	133.6	67.5	6.6	2.1	4.4	1.8	1.4	1.0	34.1	2.8
Bldg. 3025 - 3026	16.4	11.3	9.1	10.0	14.5	10.0	9.3	3.1	7.9	2.2	2.6	1.0	8.6	0.7
Bldg. 3019	10.8	11.3	10.5	10.0	10.0	10.8	11.25	11.8	9.7	3.4	3.3	2.7	9.2	0.8
Bldg. 2531	24.2	87.5	405.0	214.2	306.7	35.0	81.4	78.0	26.3	17.8	28.1	17.0	88.8	7.3
Bldg. 3525	10.8	10.0	10.0	10.0	10.0	10.0	8.1	.3	1.8	.6	1.0	1.3	6.3	0.5
Bldg. 2026	10.0	10.5	10.0	10.8	10.0	10.0	6.2	.6	2.1	.8	1.3	1.0	6.2	0.5
Tank Farm Drainage	-	-	-	134.0	276.4	227.5	350.5	545.9	601.3	1080.6	444.3	751.7	496.0	40.5
Bldg. 3505, 3517	45.0	27.5	10.0	18.3	10.0	10.0	10.0	-	-	-	-	-	20.1	1.6
Avg. Monthly Total Activity - A	1028.5	1416.9	1249.1	842.3	1098.6	690.0	812.35	1070.1	1002.1	1441.0	665.6	1104.4	1223.5	100

VOLUME (10^6 Gal)

	1970 Gross-Beta	1971 Gross-Beta 8 Mon. Avg.	1971 Sr-90 10 Mon. Avg.	1972 Sr-90	1973 Gross-Beta 11 Mon. Avg.	1974 Gross-Beta	1975 Gross-Beta	1976 Gross-Beta	1977 Gross-Beta	1978 Gross-Beta 5 Mon. Avg.	1978 Sr-90 7 Mon. Avg.	1979 Sr-90 6 Mon. Avg.	10 yr Gross-Beta Avg. (2)	10 yr Avg. % of Total
Area (MH234)	.59	.24	.16	.18	.11	.06	.07	.11	.05	.06	.10	.13	.16	3.2
Area (MH114 - MH112)	-	-	.86	.62	.41	.38	.15	.50	.48	.39	.59	.68	.52	10.0
MH112	2.50	1.36	.87	.43	.46	.49	.69	.69	.60	1.04	.90	.69	.83	16.4
Bldg. 3501 - 3508	.68	.65	.80	1.02	1.01	.47	.26	.12	.12	.15	.24	.74	.55	10.8
Bldg. 3025 - 3026	1.34	.47	.38	.39	.42	.22	.84	.29	.41	.26	.62	.38	.53	10.5
Bldg. 3019	.37	.09	.08	.08	.09	.31	.77	.58	.16	.19	.21	.28	.29	5.8
Bldg. 2531	1.00	.70	.87	.82	.56	.47	.71	.67	.31	.26	.27	.33	.60	11.9
Bldg. 3525	.81	.42	.40	.78	.47	.04	.03	.03	.08	.12	.21	.33	.32	6.4
Bldg. 2026	.13	.24	.22	.18	.14	.17	.12	.13	.12	.10	.10	.10	.28	5.6
Tank Farm Drainage	-	-	-	.82	1.03	1.02	.79	.9	.96	1.07	.90	1.45	.98	19.2
Bldg. 3505, 3517	.21	.10	.07	.02	.06	.01	.02	-	-	-	-	-	.01	0.2
Avg. Monthly Total Quantity	7.63	4.27	4.71	5.34	4.76	3.64	4.45	4.02	3.29	3.64	4.1	5.1	5.1	100
(10^6 Liters)	28.88	16.16	17.83	20.21	18.02	13.78	16.84	15.21	12.45	13.78	15.52	14.30	19.30	

NOTES: 1. Activities are given as Gross-Beta, Sr-90 or both in Radwaste Operations and Monitoring Monthly Reports.

2. For 1972 and 1979, Sr-90 activities were used in-lieu of gross-beta activities in calculating 10-year gross beta average.

3. Values taken from Coatomiris, 1980.

TABLE A.1-10 TYPICAL COMPOSITION OF LIQUID LLW[1]

Chemical/Radionuclide	Concentration
pH - 7 to 8	
Total Hardness	100 - 120 ppm
Calcium Hardness	60 - 85 ppm
Total. Alkalinity	80 - 95 ppm
Calcium	20 - 30 ppm
Magnesium	2 - 10 ppm
Sodium	25 - 30 ppm
Uranium	<0.01 ppm
Copper	0.05 ppm
Aluminum	0.01 ppm
Silicon	2.6 ppm
Iron	0.1 ppm
Nickel	0.03 ppm
Chromium	0.05 ppm
Dissolved CO_2	10.0 ppm
Bicarbonate	50 - 80 ppm
Carbonate	<1.0 ppm
Phosphate	0.89 - 3.3 ppm
Sulfate	12 ppm
Fluoride	7 ppm
Nitrate	26 ppm
Chlorine	5 ppm
Total Solids	180 ppm
Gross Beta	6.5×10^{-5} µCi/cc
Co-60	6×10^{-7} µCi/cc
Sr-90	6×10^{-5} µCi/cc
Ce-137	4×10^{-6} µCi/cc
Eu-154	3×10^{-7} µCi/cc

NOTE:

1. Composition is for mixture of all sources after collection in Equalization Basin (Costomiris, 1980).

TABLE A.1-11 SUMMARY OF ANNUAL GASEOUS RELEASES[1]

	Total Activity Released (Ci/yr)			
Year	Noble Gases	Tritium	Particulate	Other (primarily I-131
1970	$<8.4 \times 10^4$	-	0	3.5
1971	$<8.0 \times 10^4$	-	0	3.5
1972	$<8.4 \times 10^4$	-	7×10^{-3}	1.6
1973	$<7.6 \times 10^4$	-	5×10^{-3}	2.2
1974	$<10.7 \times 10^4$	60.2	5×10^{-3}	1.9
1975	$<9.7 \times 10^4$	36.8	9×10^{-3}	2.0
1976	$<6.7 \times 10^4$	19.2	6×10^{-3}	≤ 1.2
1977	$<4.8 \times 10^4$	24.0	2×10^{-3}	≤ 1.3
1978	$<6.4 \times 10^4$	14.8	3×10^{-3}	≤ 1.7
1979	$<6.4 \times 10^4$	-	2×10^{-3}	≤ 0.4

NOTES:

1. Values derived from Fisher, 1970.

TABLE A.1-12 ANNUAL GASEOUS ACTIVITY RELEASES FROM MAJOR RELEASE POINTS (Ci/yr)(1)

Release Point	Noble Gases	Tritium	Particulate	Other (primarily I-131)
Stack 2026 (HRLAL)	-	-	2×10^{-6}	0
Stack 3039 (Central Lab Facilities)	6.7×10^{4}	-	6×10^{-3}	1.04
Stack 7911 (HFIR)			2×10^{-4}	0.2
Stack 7512 (MSRE)	-	-	2×10^{-6}	0
Stack 3020 (Radiochemical Processing Pilot Plant)	-	-	1.5×10^{-5}	0
Tritium Target Fab. Bldg.	-	19.1	-	-
Bldg 4508 Ventilation				
Room 136	-	-	$<10^{-9}$	-
Room 265	-	-	$<10^{-9}$	-
Bldg 5505 Vents				
Glove Box	-	-	$<10^{-9}$	-
Hood	-	-	$<10^{-9}$	-
Total	6.7×10^{4}	19.1	6.2×10^{-3}	1.25

NOTE:

1. Releases are typical values based on releases reported in 1976 (Lasher, 1970).

TABLE A.1-13 ESTIMATED ACTIVITY/VOLUME OF FUTURE ILW INPUTS

Radionuclide	Specific Activity (μCi/cc) Pilot Plant Waste(1)	Basin 3513 Sludge(2)	Gunite Tank Sludge(3)
Sr-90	1.32×10^{3}	1.05×10^{-2}	5.5×10^{2}
Y-90	1.32×10^{3}	-	-
Ba-137M	1.22×10^{3}	-	-
Cs-137	1.32×10^{3}	6.3×10^{-2}	65
Ce-144	$.74 \times 10^{3}$	-	-
Pr-144	$.74 \times 10^{3}$	-	-
Pm-147	1.82×10^{3}	-	-
Pu-239	2.64×10^{-2}	1.6×10^{-3}	0.25
Cm-244	6.6	-	10
Total Activity	6.27×10^{3}	7.5×10^{-2}	6.15×10^{2}
Annual Volume (liter/yr)	1.9×10^{4}	-	-
Total Volume (liter)	-	3.2×10^{6}	1.3×10^{6}

NOTES:

1. Values taken from Liverman, 1977.
2. Values taken from Tamura, 1977.
3. Values taken from Ehrlich and Weeren, 1979.

TABLE A.1-14

ESTIMATED WASTE VOLUMES FOR SCHEDULED SURPLUS FACILITIES D&D PROJECTS AT ORNL[3]

	Project Description	Waste Quantity (M^3) TRU	Non-TRU	General (All Types)
1.	Molten Salt Reactor Experiment	-	-	540
2.	Metal Recovery Facility	140	285	-
3.	Radiochemical Waste System	50	170	-
4.	Fission Product Development Laboratory	-	280	-
5.	Low Intensity Test Reactor	-	-	2000
6.	Homogeneous Reactor Experiment No. 2	-	-	110[1]
7.	ORNL Graphite Reactor	-	-	2830[2]

NOTES:

1. Entombment is the disposition mode assumed for this facility.

2. Excludes the graphite reactor, which is to be preserved as a National Historic Landmark.

3. Values taken from Carroll, 1979.

ORNL DWG 81-23555

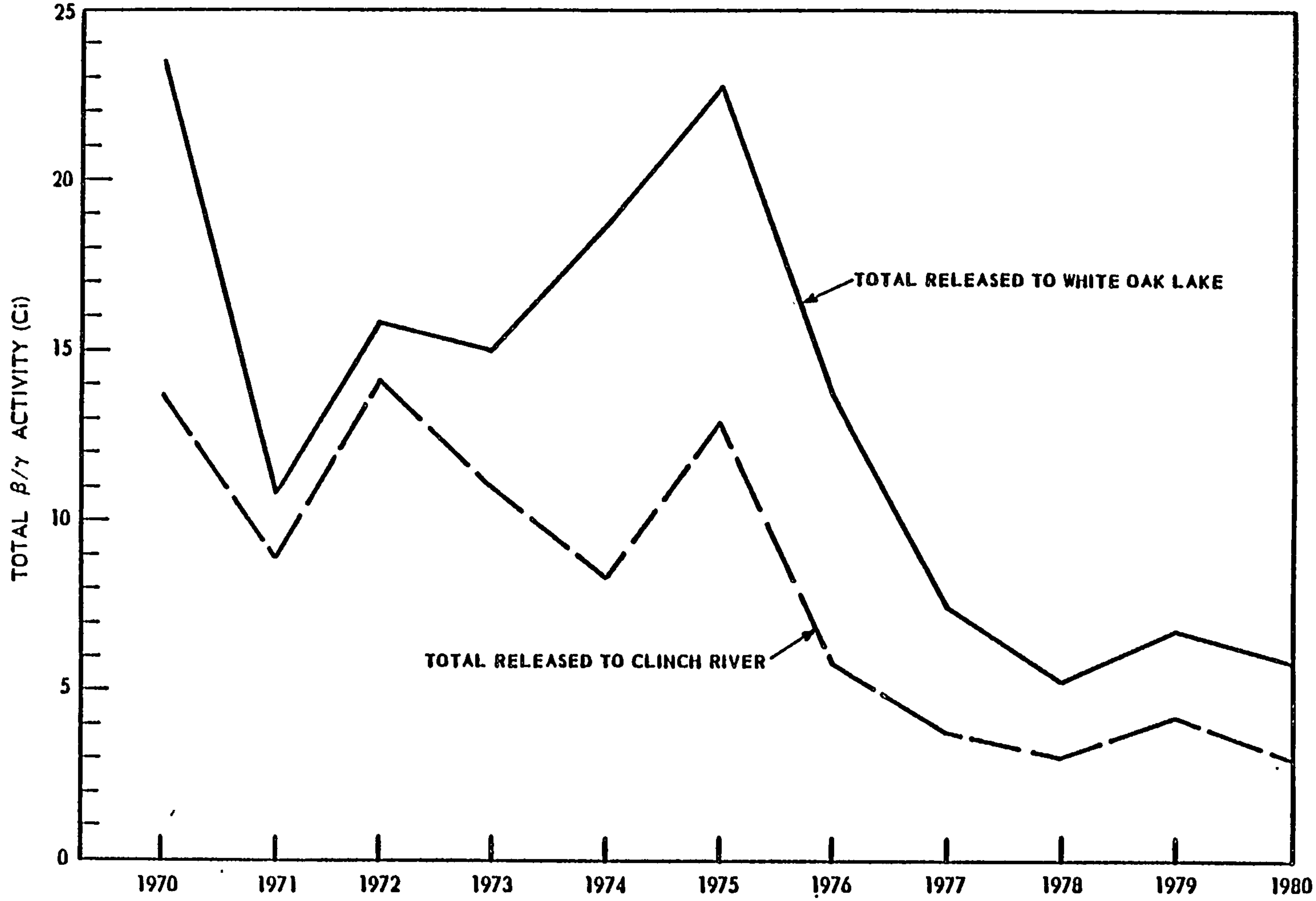


FIGURE A.1-1 TOTAL β/γ ACTIVITY RELEASED INTO WHITE OAK LAKE VERSUS AMOUNT RELEASED INTO CLINCH RIVER (VIA WHITE OAK LAKE) (Values derived from Lasher, 1970)

ORNL DWG 81-23556

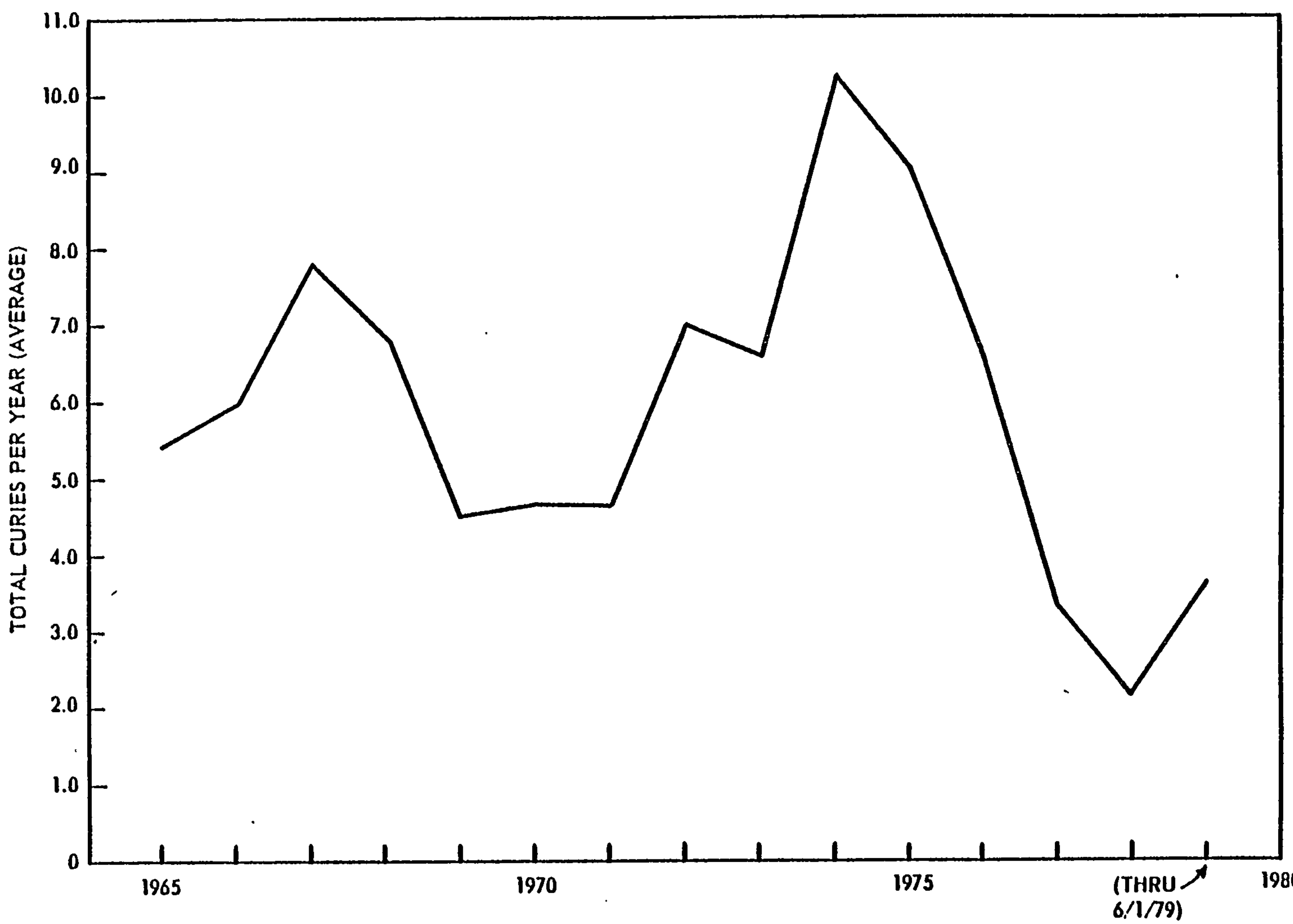


FIGURE A.1-2 TOTAL Sr-89 AND Sr-90 RELEASED TO WHITE OAK LAKE AS MEASURED AT SAMPLING STATIONS 3 AND 4 (Values derived from Costomiris, 1980)

2.0 LIQUID AND GASEOUS WASTE MANAGEMENT FACILITIES

2.1 GENERAL

Systems are provided for collection, processing, and disposal of all liquid and gaseous radioactive wastes generated by the various R&D programs and pilot plant facilities of ORNL. The majority of these wastes are transferred through piping systems to centralized facilities for processing and/or monitoring prior to disposal or discharge. In a few cases, it is not possible or practical to send a waste stream to a central processing facility. In these situations, the facility where the waste is generated provides the necessary processing and/or monitoring capabilities.

Liquid wastes are segregated into three separate categories for collection, processing, and disposal. These are: low level waste (LLW); intermediate level waste (ILW); and high level waste (HLW). A waste stream is placed into one of these subsystem categories on the basis of activity level and/or its origin. A simplified block diagram of the process flow paths for each of these subsystems is shown in Figure A.2-1.

In general, based upon historical operating practice, LLW and ILW are, in general, the only types of liquid radioactive waste that have been produced at ORNL. ILW is composed of a mixture of all of the liquid wastes, other than process (LLW) waste, that are produced in hot cell, pilot-plant, and reactor operations, including relatively small volumes of organic reagents and solvents. Accordingly, liquid high level and transuranic wastes which are produced in pilot plants and hot cells, are diluted by lower-level research wastes to form ILW.

Gaseous wastes are segregated into three separate categories for collection, based on the origin of the waste stream. These categories are: cell ventilation, off-gas, and alpha enclosure ventilation. After collection, the waste gases are filtered, monitored, and routed to either a central stack or to a local ventilation exhaust point. The basic process flow path for each of these waste gas streams is shown in the block diagram in Figure A.2-2.

2.2 LIQUID LLW SYSTEM

Liquid low level wastes are slightly contaminated aqueous solutions consisting of floor drainage, steam and cooling water leakage, flush drains, etc. A complex system of underground piping is provided to collect these wastes from source generators in Bethel and Melton Valleys as shown in Figures A.2-3 and A.2-4. This collection system consists of over 30,000 meters of 10.2 cm diameter through 76.2 cm diameter pipe, most of which is constructed of vitrified clay. The waste water flows through this piping system by gravity from the source generators to open collection ponds. At various points along the way, the flow rate and activity level in major branches of this collection system are automatically measured and read out in the Waste Operations Control Center (WOCC). After collection in the ponds, the waste water is sampled and then either sent to the LLW processing system or discharged directly, depending upon the activity level found in these samples and/or the radiation readings on the monitors upstream of the ponds. The normal flow path for the water collected in each of these ponds is shown in Figure A.2-5.

As indicated by Figure A.2-5, only the LLW from the central laboratory complex is normally processed before release to the environment. Table A.1-9 identifies the major contributors to the LLW processing system from this area in terms of volume and activity.

The LLW processing system is described briefly below. (A more detailed description of this system is given in Braatz and Robinson). The LLW processing system, which was developed by ORNL, is known as the Scavenging Precipitation-Ion Exchange Process (SPIX). A simplified flow diagram for this system is shown in Figure A.2-6. Waste water to be processed is collected in Equalization Basin 3524. Chemicals for flocculation, coagulation and pH adjustment are added and a precipitator-clarifier then removes about 50 percent of the radionuclides by passing the waste stream through a sludge-blanket. A portion of the sludge is periodically pumped as a slurry containing 2 to 4 weight percent solids to a lined settling pond in Melton Valley.

The clarifier effluent is pumped through anthracite bed polishing filters and cation resin ion exchange columns which remove nearly all of the remaining activity (primarily Cs-137 and Sr-90). The effluent from the ion exchange columns is either reused for filter backwashing and ion exchange column regeneration purposes or neutralized and discharge to White Oak Creek.

The SPIX system is designed to process waste water at a rate of 757 liter/min and to remove 99.9 percent of the residual activity in the water. Since the system was put into operation, it has processed an average of 300 liter/min and has generally achieved excellent DF values. Average removal efficiencies for several typical runs are given in Table A.2-1, which also shows that the effluent from this processing facility is well within MPC levels without any dilution in White Oak Creek, or the Clinch River. The positive effect this system has had on total site releases is reflected in Figure A.1-1, which shows that there has been a dramatic reduction in the total activity released to White Oak Lake since this system was placed in operation in the latter part of 1975.

2.3 LIQUID ILW SYSTEM

The liquid intermediate level waste (ILW) system functions to collect, neutralize, concentrate, and store aqueous solutions from "hot" sinks and drains, radiochemical pilot plants and nuclear test reactors located in both Bethel and Melton Valleys. The waste solutions drain or are discharged from the source buildings to conveniently located collection tanks. Solutions which accumulate in the collection tanks are periodically transferred to storage tanks near the evaporator annex. The waste from these storage tanks is transferred to one of the two evaporators, where the aqueous solution is concentrated by a factor of 20 to 30. Condensate from the evaporator is directed to the process waste (low-level) system. The concentrate stored at the evaporator is periodically pumped, via doubly contained transfer lines, to storage tanks located in Melton Valley near the hydrofracture site. The concentrate stored in Melton Valley is periodically disposed of by hydrofracture into the underlying shale formations. Figure A.2-7 is a schematic diagram of the ILW system showing the relationship between collection tanks, waste evaporators, transfer lines, storage tanks and hydrofracture operations.

The system originally consisted of extensive underground piping that was used to collect OR-ILW from various ORNL facilities and transport the waste to a central storage tank farm (six 644,000 liter "gunite" storage tanks). In 1949, ORNL waste operations installed a pot-type evaporator to concentrate the OR-ILW. The evaporator bottoms (concentrate) were stored in the central tank farms, and the evaporator distillate was discharged to White Oak Creek. The underground piping system subsequently was expanded by adding collection tanks near the various ILW sources. In 1954, the pot-type evaporator system was discontinued, and solar evaporation and ion exchange on native shale became the process techniques used. In 1965, the currently operating 38 liter/min evaporator was placed in service. In 1966, the concentrates were initially disposed of in a pilot hydrofracture operation (de Laguna, 1968) and distillate treated as LLW. In 1973, a program to improve the ILW system was initiated. An identical backup evaporator was installed in 1979. Construction of a new hydrofracture facility is nearing completion. Gunite storage tanks are scheduled to be decontaminated and decommissioned in-place by the end of 1983. Upgrading of other portions of this system are currently in the conceptual planning phase.

The subsystems associated with collecting and processing liquid intermediate level wastes are briefly described below. A more detailed description of this system is given by Binford, Orfi, 1978.

The ILW drains by gravity from hoods, glove boxes, sinks and cells, or is discharged by steam jets from process vessels to one of the 23 stainless steel collection tanks. These tanks and the complex system of underground piping are shown on Figures A.2-4 and A.2-8. Most of the drains outside the source buildings are stainless steel lines buried directly in the ground without cathodic protection, but there are a few short sections of tile pipe that drains cell ventilation ducts. The drain lines are not equipped with valves.

The collection tanks vary in capacity from 1900 to 57,000 liters depending on the requirements of each source. Nineteen of the 23 collection tanks are located in Bethel Valley; the remaining four tanks are located in Melton Valley and serve the HFIR, TRU processing plant, and TURF. Table A.2-2 lists the OR-ILW waste collection tanks currently in operation; Figure A.2-9 shows the locations of the collection tanks. Inactive OR-ILW tanks are listed in Table A.2-3 along with reasons for their being out of service. All of these tanks except W-19 and W-20 are scheduled for decommissioning under the Surplus Facilities Management Program. Typical installation details for the older collection tanks are shown on Figure A.2-10; details for the more recently installed collection tanks are shown in Figure A.2-11.

Waste accumulates in each tank to an administrative limit set by the operations staff (Example: Tank W1-A capacity is 15,000 liters; operating volume is 11,400 liters). In the event of tank rupture, the contents would drain to a sump located on each collection tank pad. Recently installed tanks have concrete cubicles for retention dikes.

Underground transfer lines connect the source collection tanks to the Bethel Valley collection headers. As shown in Figure A.2-6, the collection headers drain to two evaporator service tanks W-21 and W-22. The existing gunite tanks can be valved into service under emergency conditions. Transfer lines direct the waste to the evaporators.

Two 38 liter/min evaporators are located in Building 2531. These evaporators are single vessel, pot-type, natural circulation evaporators. Steam heats seven seamless coils located in the bottom 91.4 cm of the evaporator. If cooling is required in the vessel, water can be injected in the coils for proper temperature control. Each of the evaporator vessels have anti-foam injection capability and remote internal decontamination spray headers. Decontamination is possible because of impingement trays installed in the top head of the vessel. Figure A.2-12 is a cutaway section view of the waste evaporator vessel.

The evaporator is operated on a batch feed system. The vessel is filled with waste and additional feed is forwarded to the vessel as boil-off occurs. When the vessel operating level is filled with concentrated waste based on a density probe sample, the evaporation process is terminated and the waste is batch fed to the concentrates tank. The evaporator is controlled locally within Building 2531 with a malfunction alarm in the Control Complex in Building 3105.

Evaporator distillates are collected in a surge catch tank. Following radiation monitoring, the distillate is piped to the low level waste collection pond (equilization basin). Evaporator concentrates are piped to a concentrates collection tank (W-23). If additional storage capacity is required, either tank W-21 or W-22 can be kept empty for use during emergency conditions. Concentrates are subsequently pumped via a new 5 cm stainless steel line to the Melton Valley hydrofracture site storage tanks. The location of this 1828 meter line is shown on Figure A.2-13. Details of the double-contained transfer pipe are shown in Figure A.2-14.

Intermediate level waste concentrates are disposed of by hydrofracturing in a shale formation approximately 305 meters underground. Waste is pumped from the concentrate tanks to the 1,520,000 liters waste storage tanks at the new hydrofracture facility site in Melton Valley. At the facility, the waste is mixed with a clay-cement grout, and high pressure pumps inject the waste/grout mixture into the hydrofracture at 175 kg/cm^2 at a rate of 680 to 757 liter/min.

The requirements of the hydrofracture disposal process set stringent criteria for the grout properties. The grout must be: 1) compatible with the waste solutions, 2) pumpable for extended times (24 hr), and 3) retain virtually all the associated water when solidified. Another desirable characteristic is a relatively low leach rate. The blend of solids that produces groutes with these properties contains the following: 1) cement, 2) fly ash to retain strontium, 3) attapulgite clay to retain excess water, 4) a second clay to retain cesium, and 5) a retarder to delay the setting of the grout. The proportions of the different ingredients can and are adjusted to allow for considerable variation in the composition or concentration of the waste solution being injected. A more detailed description of the hydrofracture process is given by de Laguna, 1968, and 1971.

2.4 LIQUID HLW AND TRU SYSTEM

2.4.1 High Level Wastes

High level liquid wastes have not been routinely produced in significant quantities at ORNL. However, in the early 1960's, it was anticipated that some future processing operations would be required that would produce liquids with substantially higher concentrations and heat generation rates than could be handled by the existing gunite storage tanks. Consequently, in 1964, the elements of a high level waste system were installed. The system includes two internally and externally cooled 190,000 liter stainless steel tanks located in an underground reinforced concrete vault adjacent to and directly north of the evaporator building (2531). A brief description of this installation is presented below. A more detailed discussion is given by Binford and Orfi.

The two HLW storage tanks (C-1, C-2) are designed to accommodate hot acidic wastes with activities up to 740 Curies per liter. The tanks are of all welded construction, fabricated of ASTM A240-61T Type 304 L stainless steel, 1.27 cm thick. The 18.6 cm long by 3.7 cm diameter horizontal tanks were designed to meet the requirements of ASME Code Section VIII. Only one tank, (C-2), is used to receive HLW input and the second tank is available as a standby to receive the contents of the first tank in case of leakage.

In addition to the tanks, 2.54 cm stainless steel lines have been installed in concrete conduits from the Pilot Plant, (Building 3019), and the Fission Product Development Laboratory, (Building 3517), to the HLW tanks but have not been connected. HLW from these laboratories are currently being stored locally. Valve pit, piping and shielding for the evaporator facility and C-1 and C-2 tanks are designed such that HLW may also be concentrated in the evaporator. Schematics of the HLW storage tanks and vault are shown on Figure A.2-15 through A.2-17.

2.4.2 Transuranic Wastes

Until 1970, transuranic liquid wastes were diluted, neutralized with caustic, and transferred by pipeline to a storage tank (W-6) in Bethel Valley. In 1970-71, processing of some Savannah River slugs and target tubes in the TRU facility resulted in significant increases in the quantity of waste generated. These increased wastes and leaks in the transfer line resulted in trucking several thousand gallons of this "high level" transuranic waste to the high level waste storage tanks discussed above. Transfer of the waste via a new pipeline was resumed in mid-1972.

Currently transuranic liquid wastes are administratively segregated in the TRU process area and forwarded to collection tanks in Melton Valley (Figure A.2-18). With the exception of the High Flux Isotope Reactor (HFIR) collection tank (located southwest of HFIR (Bldg. 7900), these tanks (T-1, T-2 and WC-20) are located near the Melton Valley pumping station. ILW and TRU contaminated liquids from the HFIR and TRU-TURF complexes are transferred to these tanks and subsequently pumped to the evaporator feed tanks and processed as ILW. Tanks T-1 and T-2 have a capacity of 57,000 liters each, and were installed in 1962; WC-20 is a 38,000 liter collection tank recently installed as part of the current ILW system modification to serve the TRU-TURF complex, (Figure A.2-11). Design details for this collection and the associated transfer system are described by Binford, and Orfi.

2.5 GASEOUS RADIOACTIVE WASTE SYSTEM

Radioactive waste gases originate from ORNL research activities such as chemical processes, reactor operations and routine experimental laboratory operations. The major quantity of gaseous wastes from these operations are collected in the ductwork at the source generating facilities and discharged to the atmosphere from one of six stacks. Waste gas streams emanate principally from cell ventilation, (which represents approximately 99 percent of the volume, but very little activity) and off-gas process systems (which contains most of the activity, but very little volume).

The originating waste gas generator is primarily responsible for first-order cleanup of the gas stream prior to discharge into the gaseous waste vent systems. Numerous laboratory operations which generate small quantities of radioactive gases are not connected to one of the vent stacks but discharge their waste gases directly after local cleanup. A variety of cleanup equipment, (i.e., roughing, absolute, HEPA and charcoal filters), are employed both at the stacks and in local work areas for treating gas streams prior to release to the atmosphere.

Gaseous effluents are moved through these ventilation systems via the use of fans and blowers. Steam powered backup fans are provided for reliability purposes, but in many cases these are not adequate to provide sufficient flow to maintain building containment during power outages or maintenance periods.

Gaseous wastes from operations in Melton Valley are discharged from two stacks: 7911 and 7503. The 7911 stack serves the duct system connected to the High Flux Isotope Reactor (HFIR), Transuranium Processing Plant (TRU) and the Thorium-Uranium Recycle Facility (TURF) This stack is 76 meters high with inside diameter of 4.27 meters at the base and 1.5 m at the top. The average discharge rate is 1415 m^3/min. Gaseous effluents from the Molten Salt Reactor Experiment (MSRE) are discharged via Stack 7503. This metal stack is 30.5 m high, with an inside diameter of 1.22 m at the base and 0.92 m at the top. The average discharge rate is 280 m^3/min. The MSRE has been retired from service.

Gaseous wastes from operations in Bethel Valley are discharged from four stacks: 6010, 3020, 2026 and 3039. Stack area 6010 serves the Oak Ridge Electron Linear Accelerator (ORELA). The metal stack is 14.3 m high with an inside diameter of 0.76 m and an average discharge rate of 450 m^3/min.

Ventilation air from the Pilot Plant, Building 3019, is released at the 3020 stack. The double wall stack is 61 m high with an inside diameter of 2:0 m and an average discharge rate of 700 m^3/min.

Stack 2026 discharges ventilation air from the High Radiation Level Analytical Laboratory. This metal stack is 23 m high, with an inside diameter of 1.1 m and an average discharge rate of 620 m^3/min.

The central cell ventilation and off-gas systems, serving most of the Bethel Valley area, terminate at the 3039 stack. This stack is the principal ORNL release point, through which at least 90 percent of the measured gaseous activity generated at the Laboratory is discharged to the atmosphere. Schematic system ducting details for this stack area are shown on Figures A.2-19 and A.2-20. Summary system data is presented on Figure A.2-21.

Negative pressure for the 3039 stack main cell ventilation system is produced by electrically-driven fans (steam-driven auxiliary fans - 2690 m^3/min capable of moving approximately 5520 m^3/min. High efficiency particulate filters are provided to remove contaminates prior to release from the 76 m stack. The main off-gas system is served by a 113 m^3/min electric blower (standby steam blower -

113 m^3/min). Since the off-gas system must dispose of organic vapors and acid/caustic fumes in addition to radioactivity, a caustic scrubber is provided to remove particulate material. In the event of a loss of primary vacuum, the gas is routed through an electrostatic precipitator prior to release. Other gaseous streams to the stack are routed through roughing, charcoal, and absolute filters.

The gaseous waste system was installed 20 to 30 years ago and has undergone periodic modifications since then. It is presently in need of repair and upgrading to the current state of the art practices. Much of the visable ductwork is corroded and no longer leak tight, allowing the uncontrolled and unmonitored release of radioactive effluents. Standby capacity is insufficient to maintain system integrity during emergency conditions. Maintenance is difficult and in some cases hazardous to personnel. Fire protection capability is inadequate by current standards. These conditions have been recognized and an improvement project is currently underway to replace and upgrade the 3039 stack area off-gas and cell ventilation system, (Maier, 1979).

2.6 DESCRIPTION OF EFFLUENT RADIATION MONITORING SYSTEM

The current radiation monitoring system monitors liquid and gaseous effluents released to the environment. The system consists of radiation detectors located at selected locations with readout in the Waste Operation Control Center (Bldg. 3105). A brief description of the waste operation control complex and the liquid and gaseous effluents monitoring systems follows. A more detailed description is given in ORNL, 1970.

2.6.1 Waste Operation Control Center

The Waste Operations Control Center (WOCC) contains a small instrument shop, some office space, and two rows (north and south) of vertical control panels consisting of a total of approximately 10 lineal meters of control board. The control center contains QC surveillance to monitor and record the operating characteristics of the liquid and gaseous radwaste systems at ORNL. Data from remote instrumentation channels are telemetered to the WOCC. A shift operator is on duty providing round-the-clock surveillance. In the event of an abnormal activity release or an exceeded operating limit, the shift operator must alert supervision and the respective facility so that corrective action can be immediately taken.

The type of data monitored at the control center is summarized as follows:

- o Wind direction, velocity, temperature
- o Stack and duct gaseous effluent flowrate
- o Local air monitor radioactivity
- o Stack and duct gaseous effluent radioactivity
- o Stack and duct radiation monitor alarm modules
- o Cell blower status
- o pH, oxygen, temperature
- o Process waste water flow rate
- o Process waste water radioactivity
- o OR-ILW tank levels
- o Evaporator foam level alarms

The WOCC consists of antiquated, current consumptive, heat producing, high maintenance components such as:

- Large case multipoint strip chart recorders and small pen-type Rustrack recorders. These recorders use large quantities of chart paper which must be stored and retrieved on demand. Inking is always a problem. In addition, the chart paper guide scales are not correlated to the range of the instrument. Reading of the chart is inaccurate and difficult.

- Contact-type meters are used on count-rate meters for alarm functions. These can become problem areas due to sticking upon actuation.

- Peg board status is employed for remote count-rate meter range status.

Although the present design and existing hardware functions and serves its purpose, it has been recognized that upgrading of this equipment is required. A new WOCC is currently under design and the existing electronic equipment will be replaced by a modern data acquisition system.

2.6.2 Liquid Effluent Monitoring

Seventeen manholes in the LLW system serve as collection stations to accumulate liquid effluent from groups of buildings for the purpose of monitoring for radioactivity and measuring stream flowrate. One is located at the inlet to the equalization basin where all tributaries join, and the rest are in the main tributaries of the system. Monitoring cabinets located nearby at ground level service each of these manholes (Figure A.2-22). The liquid effluent in the manhole is measured for alpha emitting radioactivity and/or beta-gamma radioactivity. Specific manhole designations, inlet sources, and type of radiation monitor are shown in Figure A.2-23. All data is telemetered to the Control Center for alarm and recording. No control functions are associated with these monitoring stations. Automatic diversion valving has been disabled. A typical manhole installation is shown in Figure A.2-24. Abnormal volumes or activities in the system can be identified from the data provided from these monitoring stations. Instrumentation at the WOCC directs the operator to the general area where the discharges occur, and the release generator is directed to take corrective action.

A low range gamma detector monitors the effluent prior to discharge to the White Oak Creek. If the activity exceeds a predetermined level, an alarm is sounded, and discharge is discontinued until corrective action is taken.

2.6.3 Gaseous Effluent Monitoring

The gaseous effluent monitoring system provides monitoring of principal ventilation ducts and release stacks for radioactivity. Continuous monitoring and sample collection methods are used. All instrumentation transmit signals to the WOCC for monitoring and recording. Gaseous effluents are monitored for one or more of the following contaminants before being discharged to the atmosphere: beta-gamma emitting particulates, alpha emitting particulates, radioiodine, and inert gases such as zenon, krypton, and argon along with other radioactive gases. Special in-stack samplers collect inventory samples. Data obtained from analysis of these samples together with sampling time and effluent flowrates, are used to determine total particulate and radioactive activity discharged.

Radiation and flow monitoring devices are similar for all major ductwork and stacks. The 3039 stack monitoring and sampling system shown in Figure B.2-25 is typical of those used in other stacks. For the 3039 stack, monitors are located on a platform at the 15.25 m level, except for the inert gas monitor which is located at ground level. The gaseous effluent stream is monitored for beta-gamma and alpha emitting particulates, radioactive gases, and iodine. Table A.2-4 lists the location of specific stack monitors and flowrate measurement capability.

Figure A.2-26 details the in-stack sampler assembly utilized to collect samples for laboratory analyses. The gaseous effluent sample withdrawal method attempts to achieve representative sampling isokinetically. However, due to varying flowrates into the stack from user facilities and the changing air flow velocity patterns, isokinetic sampling is not achieved. Investigations are currently underway to determine the feasibility of installing automatic isokinetic sampling capability in the ORNL stacks.

In the stacks and ducts, where count rate meters are located external to WOCC, a signal is telemetered to the Center for recording and/or alarm. Alarms indicate high radiation, in-operation, tape break, or pump failure. The location of stack monitors and ratemeters on stacks other than 3039 are as follows:

Stack	Stack Monitor Location	Ratemeter Location
7911	Platform at 15.25 m stack level	HFIR Auxiliary Control Room
3020	Platform at 16.76 m stack level	Building 3082
2026	Duct from High Radiation Level Analytical Laboratory	Building 2026
6010	Duct from Electron Linear Accelerator	Building 6010
7503	Platform at 12.2 m stack level	Building 7503

TABLE A.2-1

TYPICAL PERFORMANCE DATA FOR THE LLW SPIX PROCESS[1][2]

ISOTOPE	DF VALUE	REMOVAL EFFICIENCY (%)	% OF MPC IN EFFLUENT
Sr-90	7300	99.98	5
Cs-137	2	50	10
Co-60	1.5	33.3	<1
Eu-154	40	97.5	<1

NOTES:

1. Data from Chilton, 1980.

2. SPIX, Scavenging Precipitation Ion Exchange

TABLE A.2-2

ACTIVE ILW COLLECTION TANKS(3)

Tank No.	Building Served	Capacity (Gallons)(4)	Operating(1) Volume (Gallons)(4)	Diameter(5)	Length(2,5)
W1-A	2026 & 3019	4,000	3,000	7'-6"	13'-6" H
WC-2	3028	1,000	700	5'-6"	7'-4" V
WC-3	3025	1,000	700	5'-6"	7'-4" V
WC-4	3026	1,700	1,200	7'-0"	7'-0" V
WC-5	3503	1,000	750	5'-6"	7'-4" V
WC-6	3508	500	350	4'-6"	5'-8" V
WC-7	3504	1,100	750	5'-4"	7'-5" V
WC-8	3503	1,000	750	5'-6"	7'-4" V
WC-9	3503	2,150	1,550	7'-0"	10'-9" V
WC-10	Isotope Area & 3039 Stack	2,300	1,650	6'-4"	10'-4" H
WC-11	4501	4,600	2,900	7'-8"	13'-8" H
WC-12	4505	1,000	700	5'-6"	7'-4" V
WC-13	4500N	1,000	700	5'-6"	7'-4" V
WC-14	4501	1,000	700	5'-6"	7'-4" V
WC-19	3042	2,100	1,500	6'-1"	9"-8" H
WC-20	7920 & 7930	10,000	7,000	10'-0"	19"-6" H
W-12	3525	700	400	4'-0"	5'-4" V
W-16	3026D	1,000	700	5'-6"	7'-4" V
W-17	3026C	1,000	700	5'-6"	7'-4" V
W-18	3026C	1,000	700	5'-6"	7'-4" V
T-1	7900	15,000	10,500	10'-0"	27'-6" H
T-2	7920	15,000	10,500	10'-0"	27'-6" H
HFIR	7900	13,000	9,100	8'-0"	35'-0" H

1. Normal maximum volume of waste permitted.
2. Vertical tanks are designated by V and horizontal tanks by H.
3. Data taken from Binford and Orfi, 1978.
4. To convert gallons to liters, multiply by 3.79.
5. To convert feet to meters, multiply by 0.3048.

TABLE A.2-3
INACTIVE ILW COLLECTION TANKS[1]

Tank No.	Description & Location[2]	Remarks
W-1 & W-2	Concrete tanks located in north tank farm.	Out of service because of leaks. Highly contaminated internally.
W-3 & W-4	Concrete tanks located in north tank farm.	Tanks do not leak, but collect surface water. Highly contaminated internally.
W-11	Gunite sprayed tank used for Building 3550 located near south tank farm.	Removed from service because of leaks. Highly contaminated internally.
W-13, W-14, & W-15	Stainless steel tanks located in north tank farm.	Out of service since 1958. Conflicting reports exist as to their contents. All are highly contaminated.
W-19 & W-20	2250 gal stainless steel tanks located near south tank farm were used for PPDL wastes.	The tanks do not leak, but out of service since 1960. May contain some liquid and sludge. Highly contaminated internally.
WC-1	2000 gal stainless steel underground tank located west of Bldg. 3037.	Abandonded in 1968 because of leaking discharge line. Contains Curie quantities of Co-60, Cs-137, and Sr-90 residual contamination.
WC-15 & WC-17	1000 gal stainless steel underground tanks used for 4500 area. Located south of Bldg. 3500.	Removed from service because of leaks. Highly contaminated internally.
Th-1, Th-2, & Th-3	Stainless steel tanks located south of Bldg. 3503. Were used for wastes from Fission Product Development Laboratory.	Tanks are empty, but are contaminated internally with thorium.
Th-4	Gunite sprayed concrete tank located southwest of Bldg. 3500.	The tank is out of service, but, at present, contains sludge. The sludge will be removed as a part of the proposed campaign to remove sludge from six gunite tanks in the south tank farm.

NOTES:
1. Costomiris, 1980
2. To convert gallons to liters, multiply by 3.79.

TABLE A.2-4

GASEOUS WASTE DISPOSAL SYSTEM[1]
RADIATION MONITOR LOCATIONS

STACK	MONITORS: Stack High Level	Stack Alpha Particulate	Stack BetaGamma Particulate	Stack Iodine	Stack Sampler - 2	Stack Inert-Gas	MONITORS: DUCT Beta-Gamma Particulate (Source)	Duct Flowrate Monitor	Stack Flowrate Monitor
3039 (Primary)		X	X	X	X	X	Bldg. 3025/3025	X	X
							3500 Area	X	
							Isotope Area (BLdg. 3110)	X	
							4500 Area	X	
							Main-off gas System		
7911 (Melton Valley)	X	X	X	X	X	X	HFIR	X	X
							TURF	X	
							TRU	X	
7503 (MSRE)-Inactive		X	X	X	X	X			X
3020		X	X	X	X	X			X
2026 (HRLAL)			X		X	X			
6010 (ORELA)			X			X			

NOTES: Costomiris, 1980

ORNL DWG 81-23557

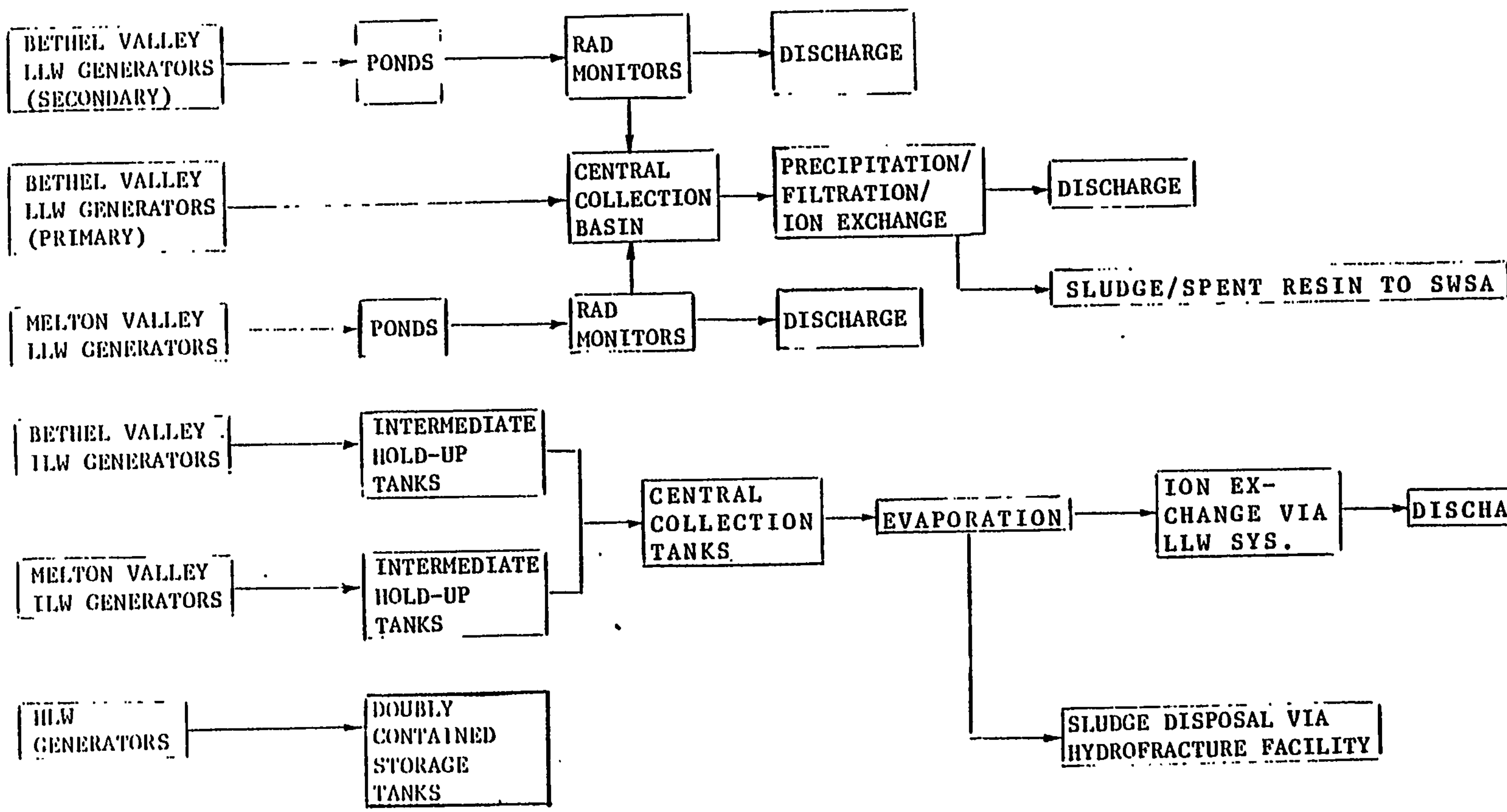


FIGURE A.2-1 BLOCK DIAGRAM OF LIQUID RADWASTE SYSTEMS

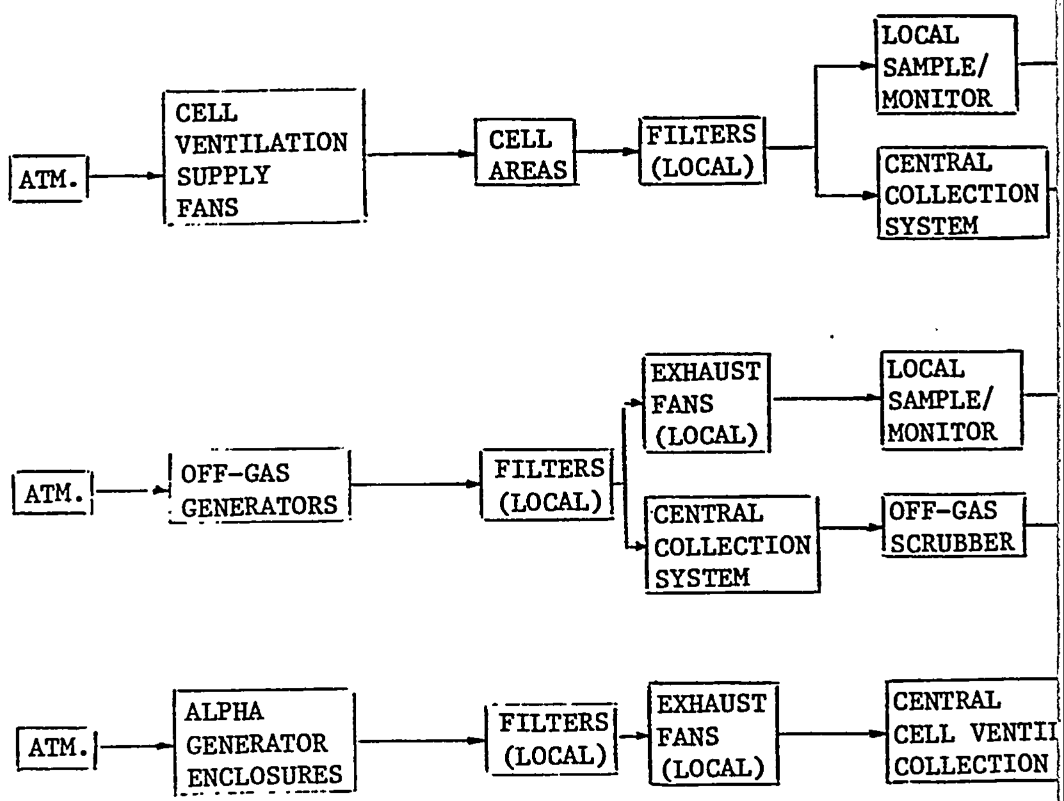
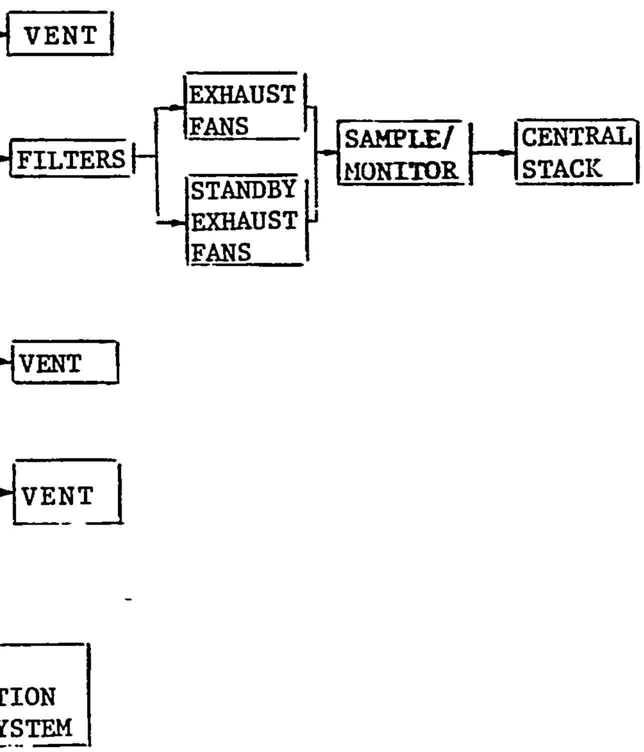


FIGURE A.2-2 BLOCK DIAGRAM OF GASEOUS RA

ORNL DWG 81-23558



ASTE SYSTEMS

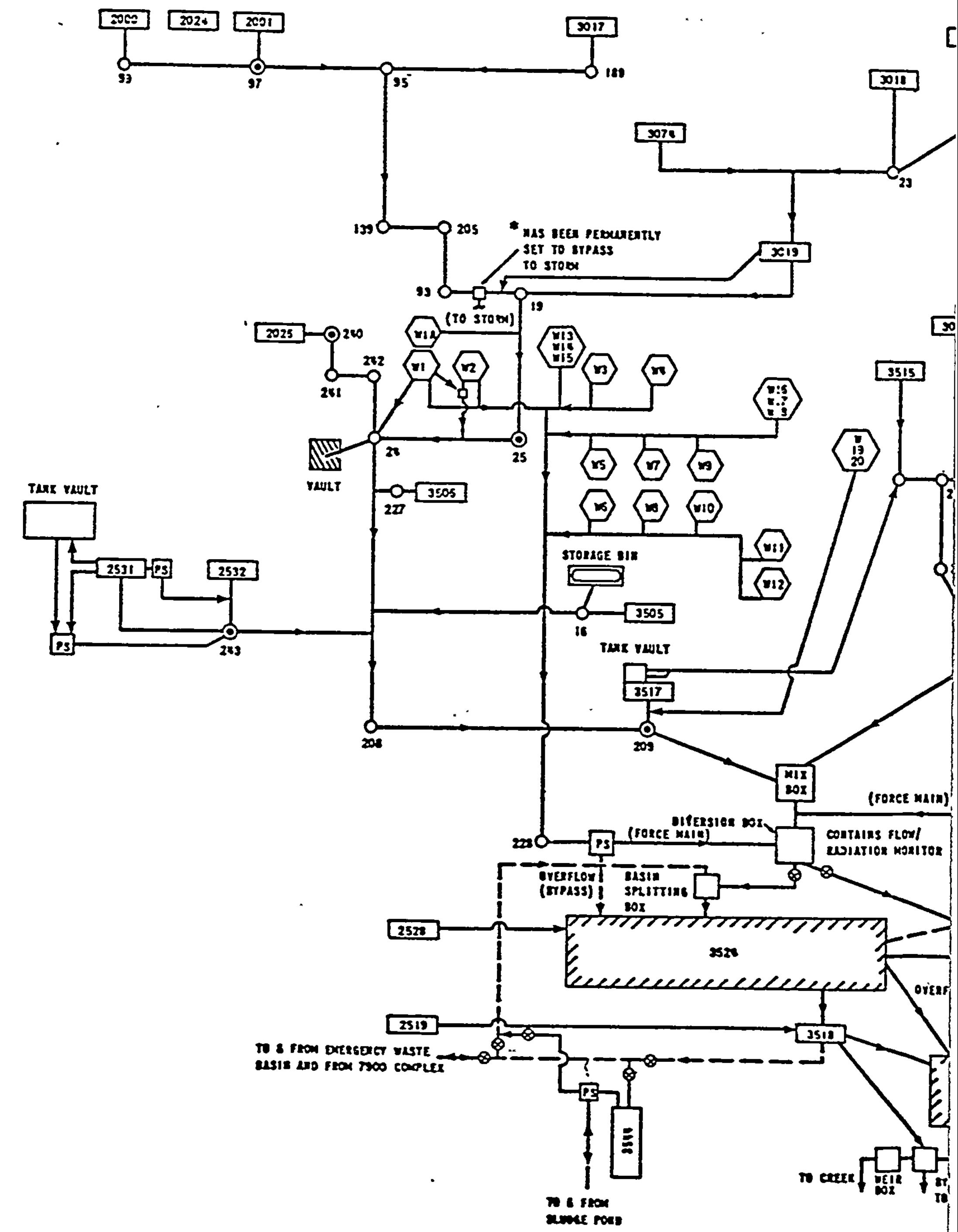
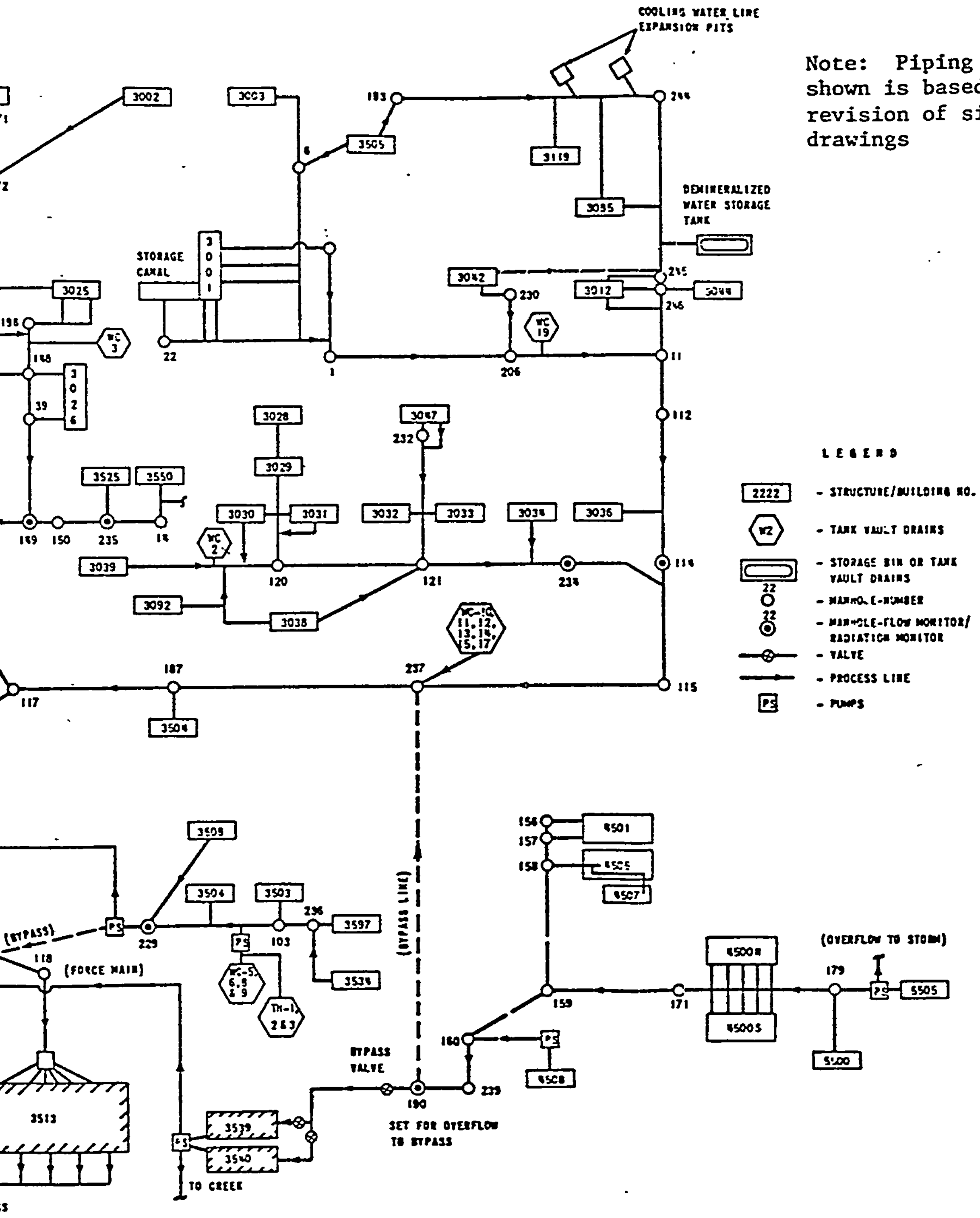


Figure A.2-3 Block Flow Diagram for Liquid LLW Collection Subsystem

ORNL DWG 81-23590

Note: Piping arrangement shown is based on 1970 revision of site "atlas" drawings



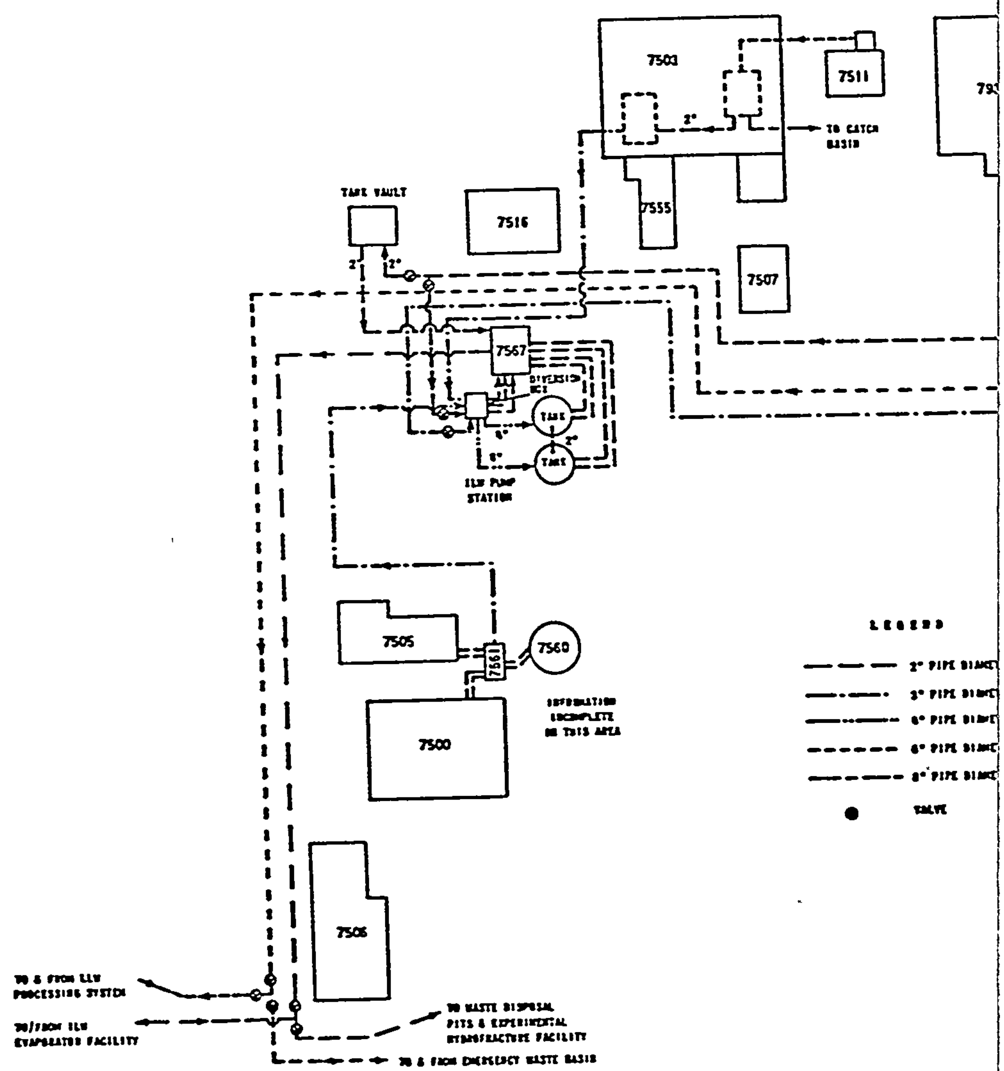
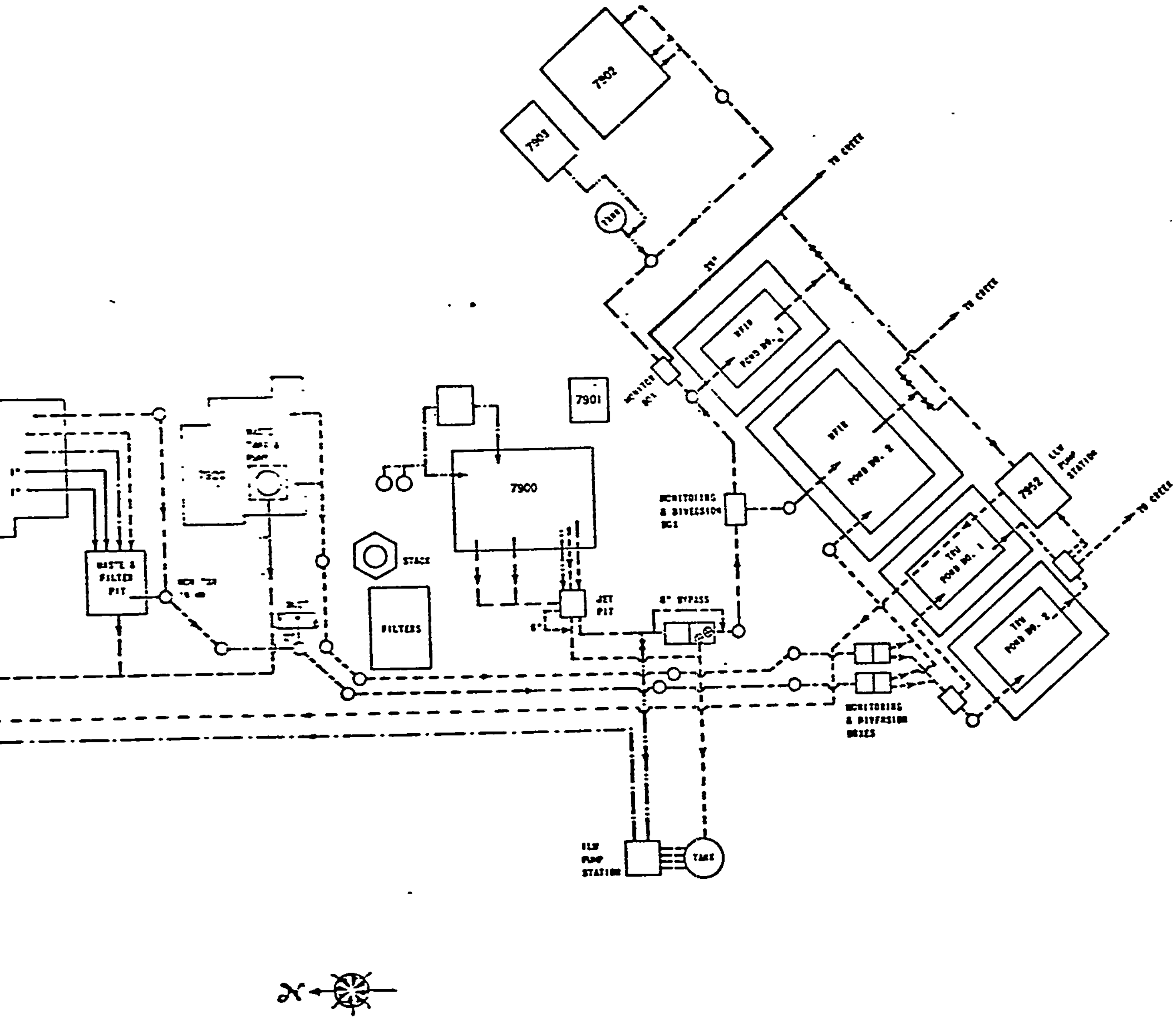


Figure A.2-4 Melton Valley Liquid LLW and ILW Collection Systems

ORNL DWG 81-23591



Note: Piping arrangement shown is based on 1970 revision of site "atlas" drawings

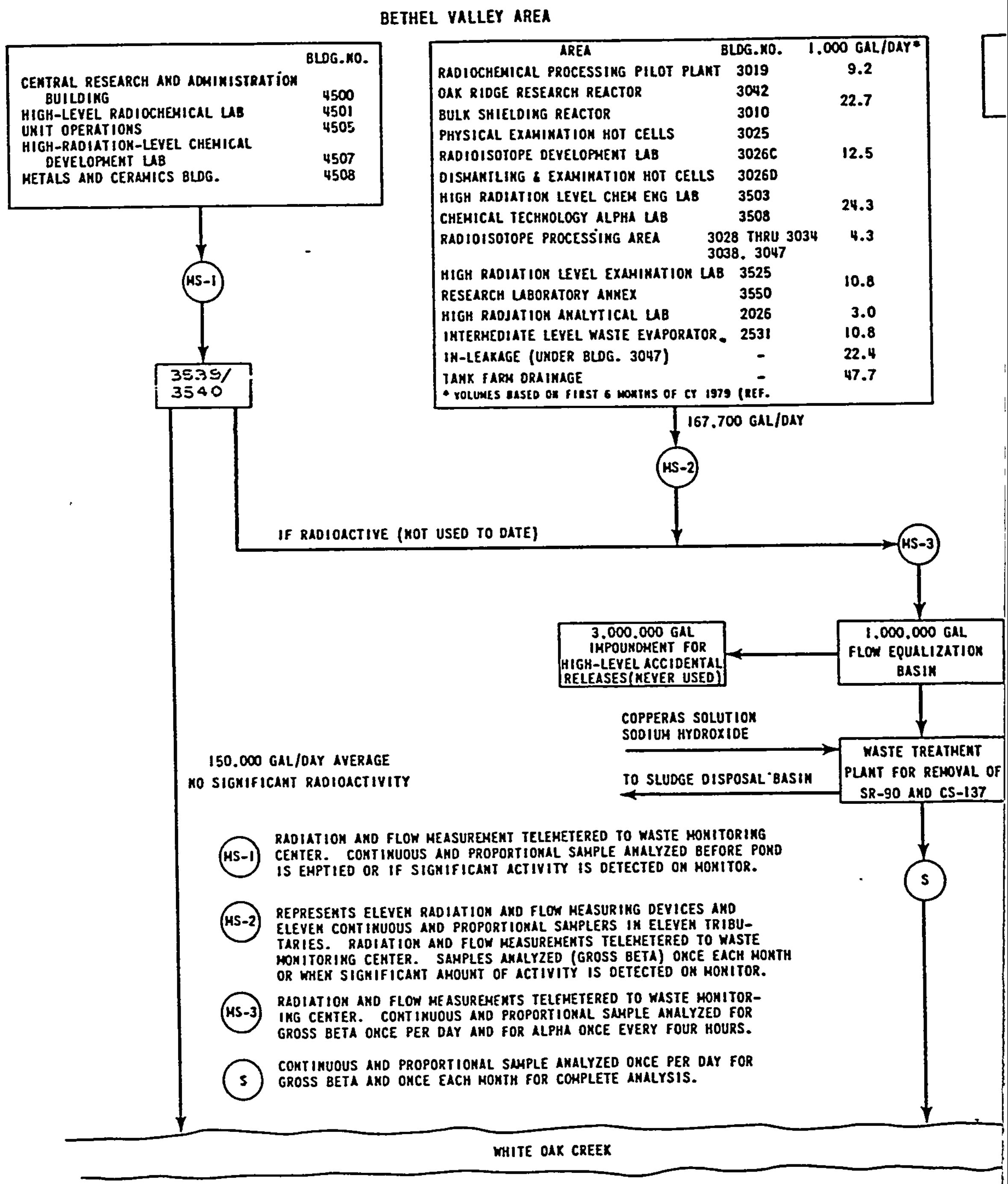
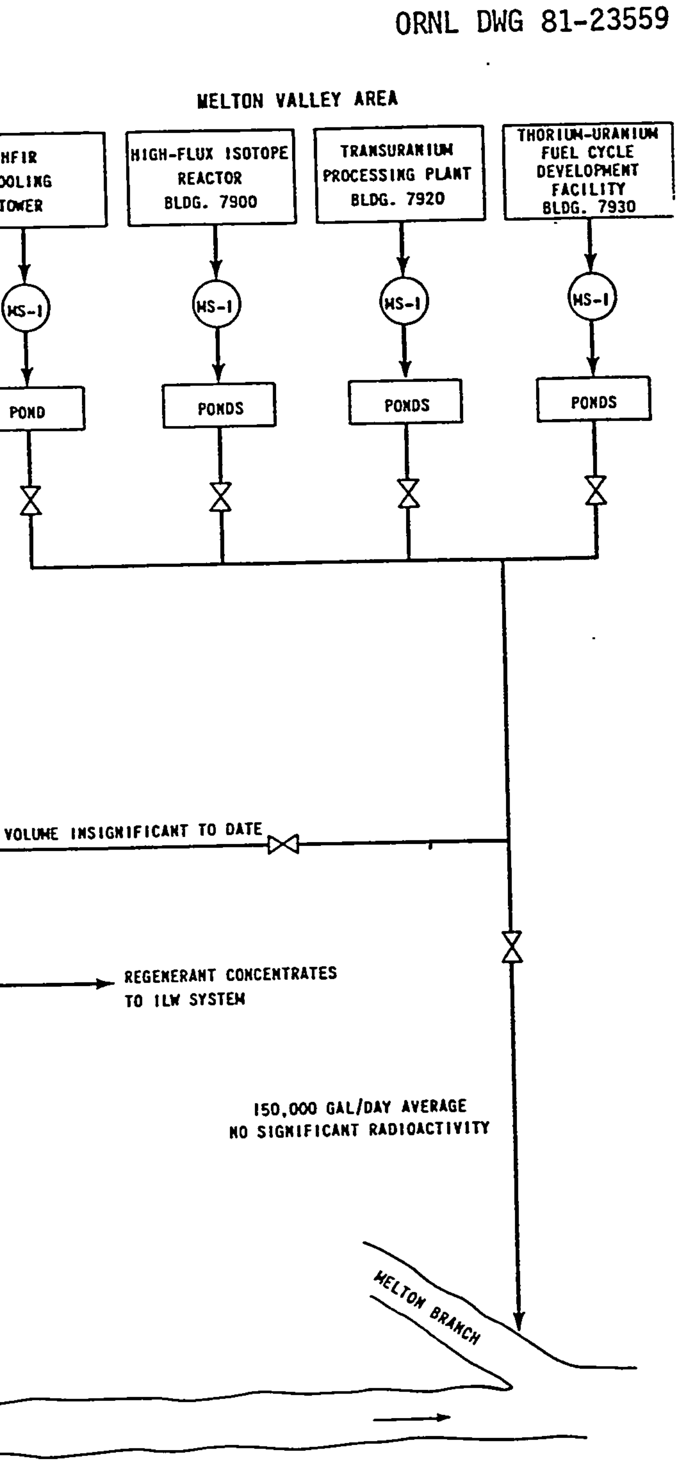


FIGURE A.2-5 LLW COLLECTION SY



TEM (Costomiris, 1980)

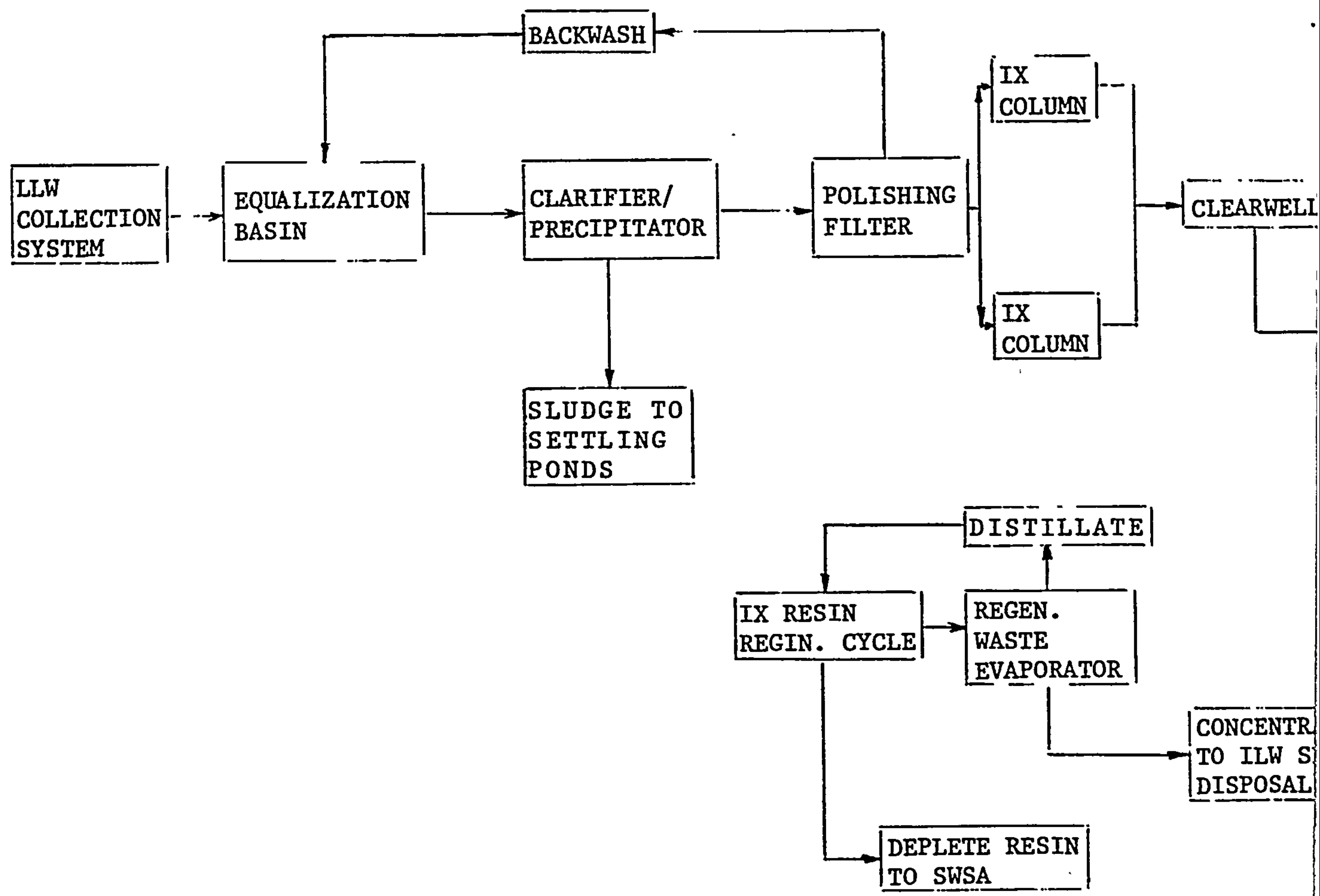
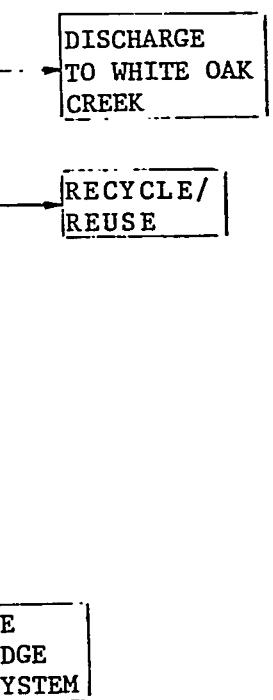


FIGURE A.2-6 PROCESS FLOW DIAGRAM FOR LLW SP-IX SYSTEM

ORNL DWG 81-23560



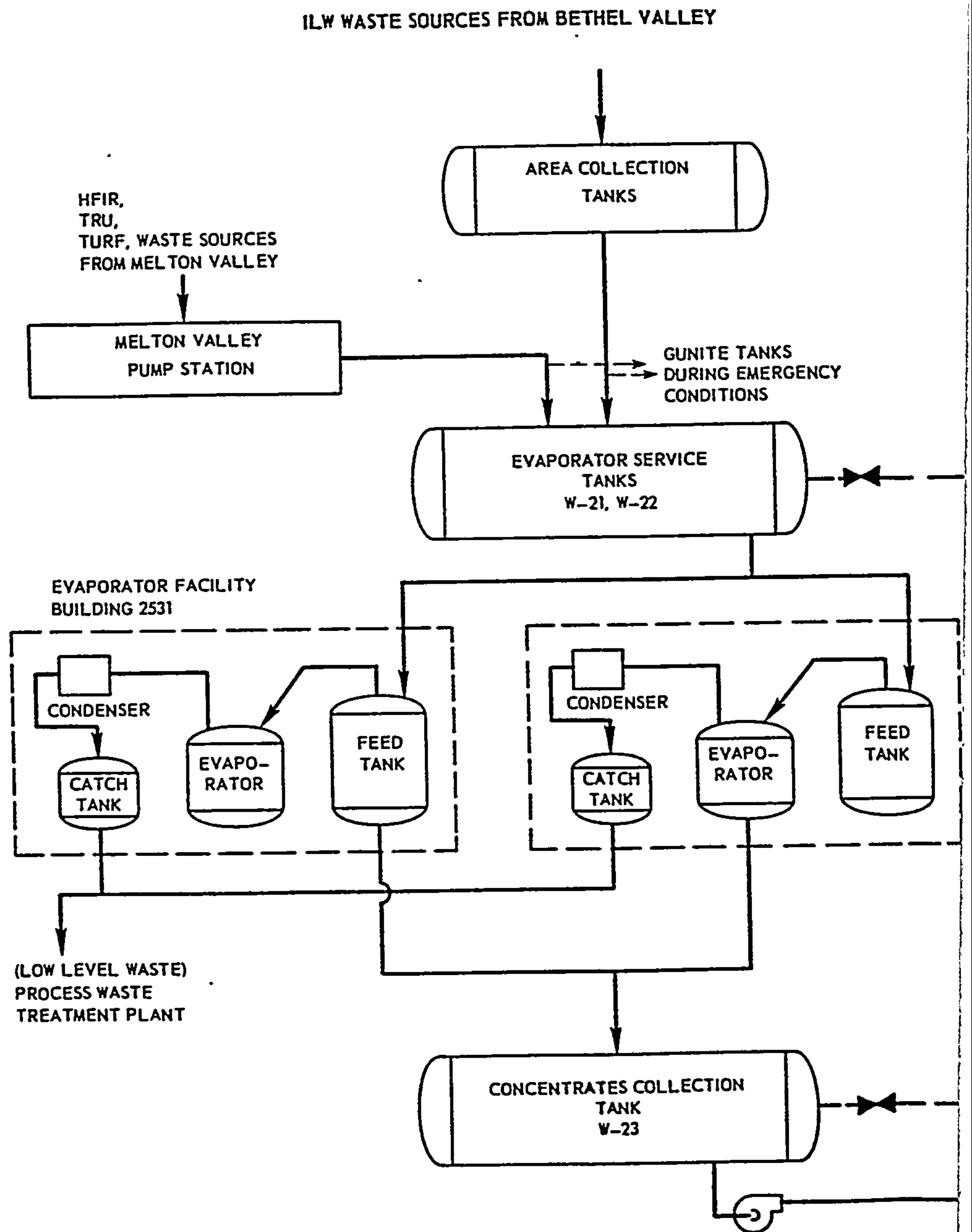
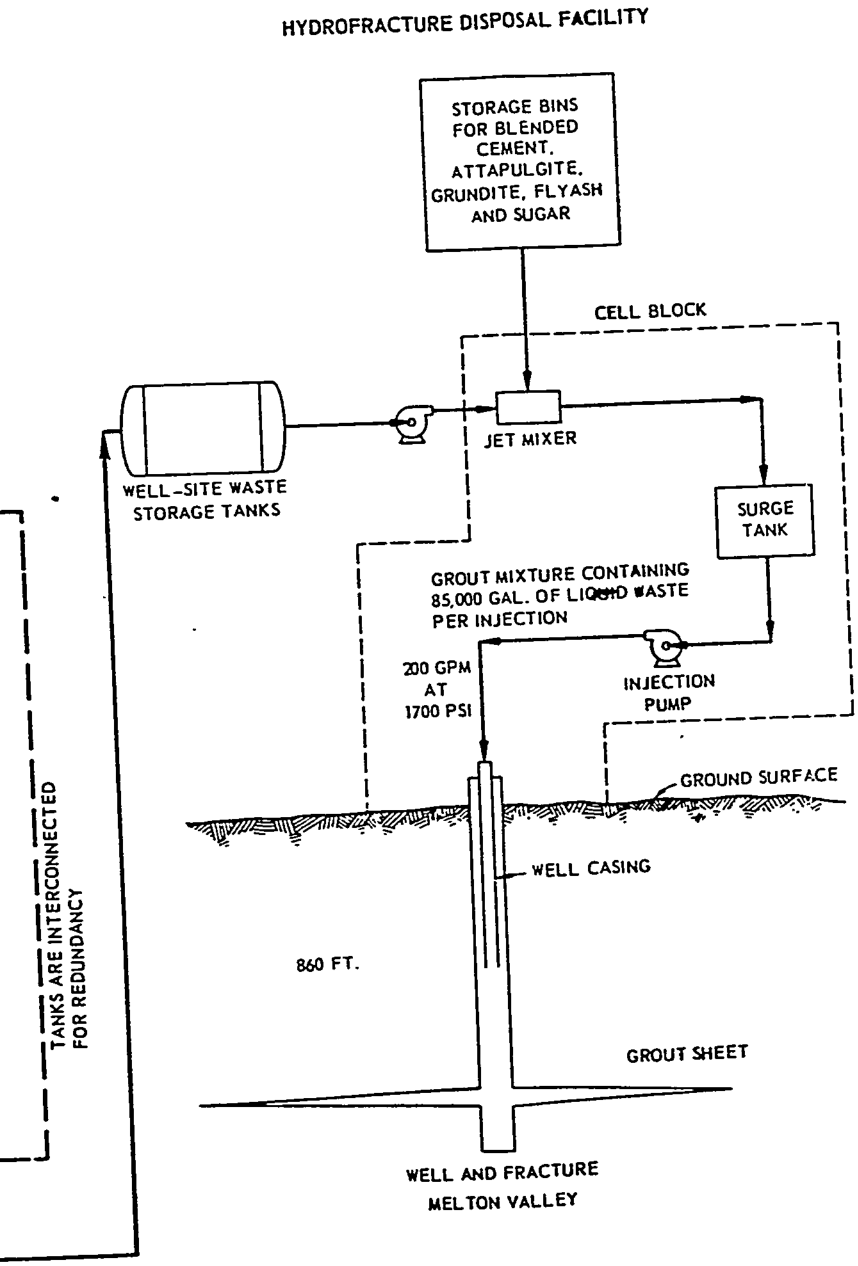


FIGURE A

INTERMEDIATE LEVEL

ORNL DWG 81-23561



2-7

ASTE SYSTEM (Costomiris, 1980)

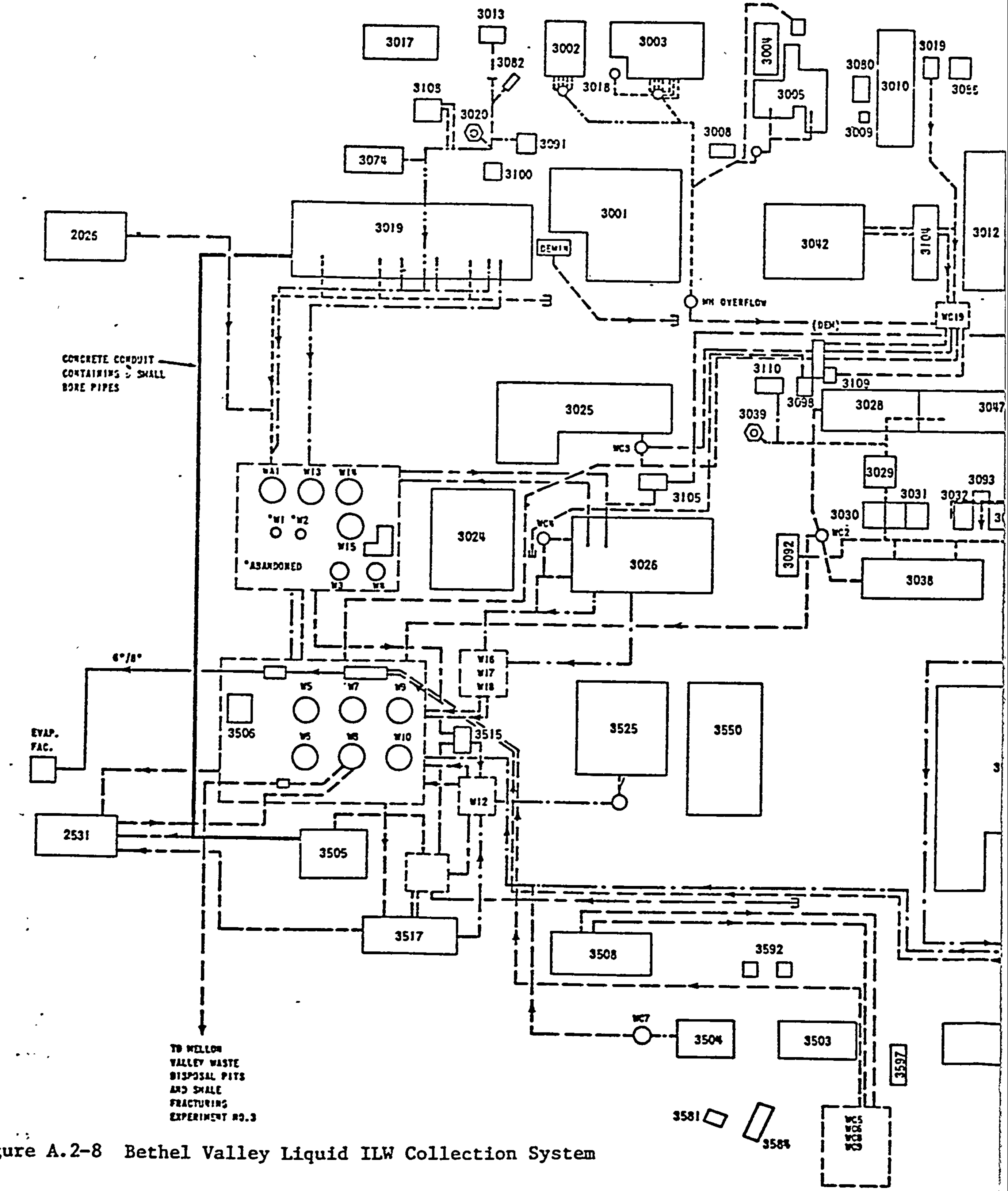
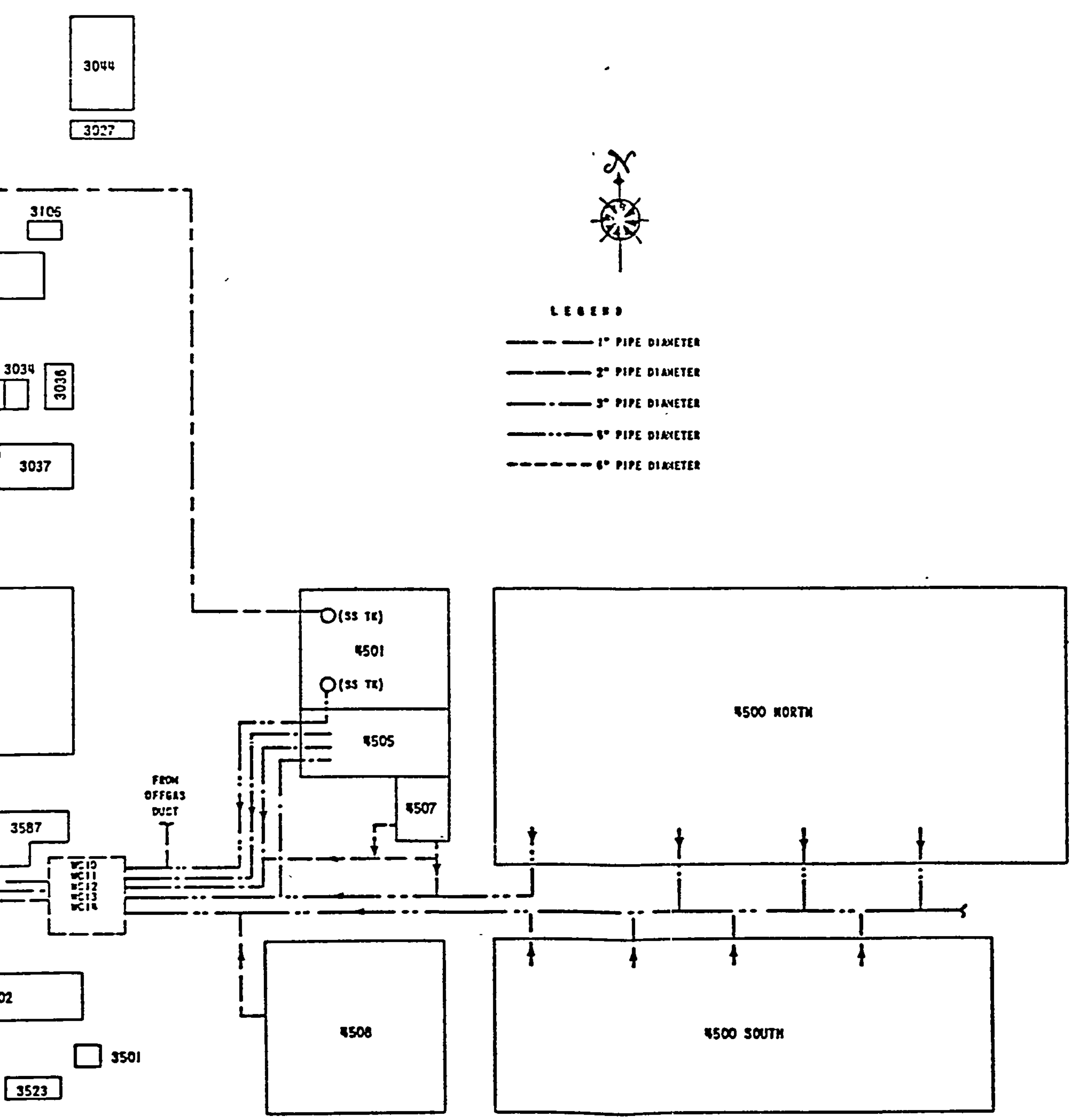


Figure A.2-8 Bethel Valley Liquid ILW Collection System

ORNL DWG 81-23592

Note: Piping arrangement shown is based on 1970 revision of site "atlas" drawings



ORNL DWG 81-23563

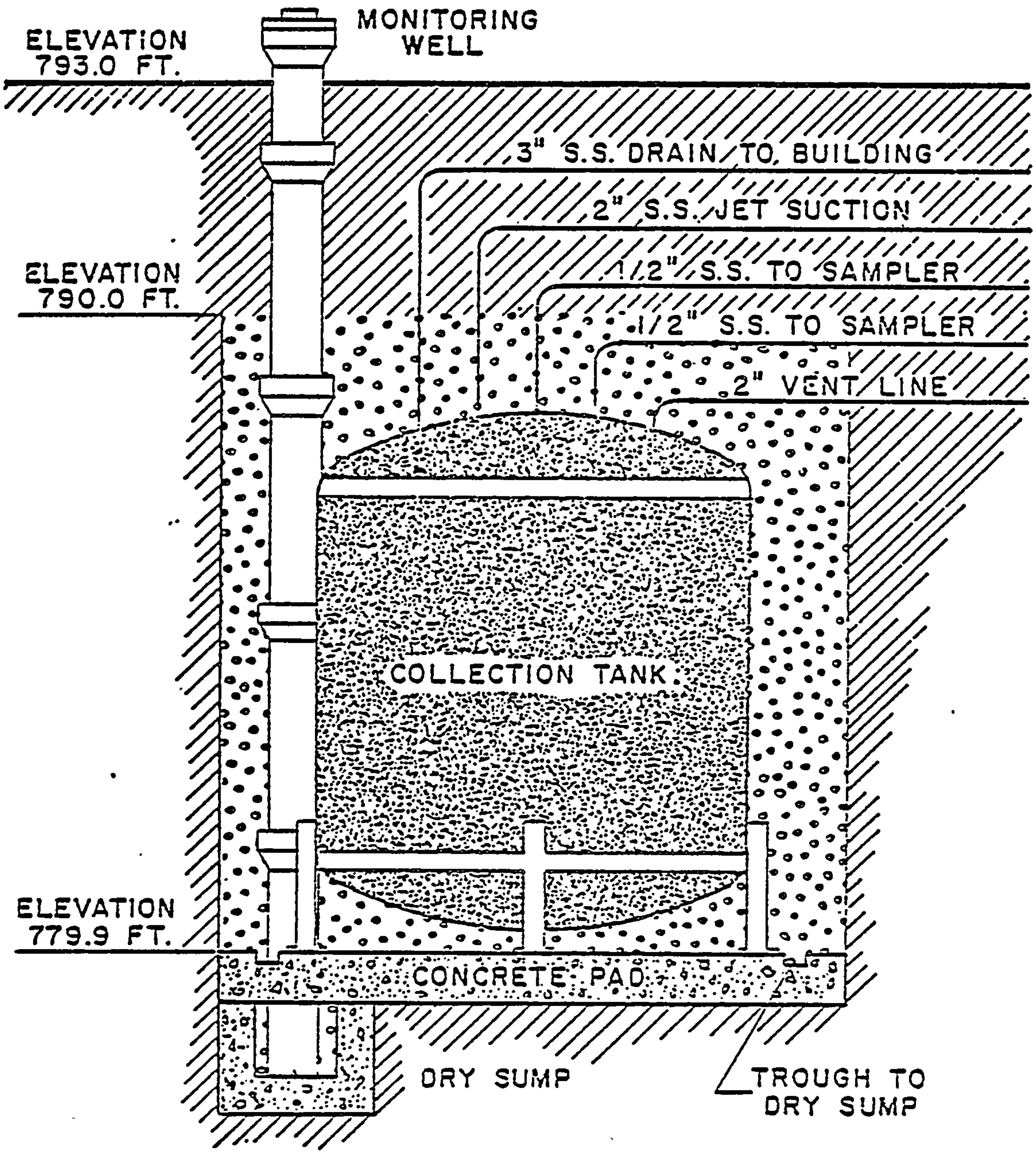


FIGURE A.2-10 TYPICAL OLDER COLLECTION TANK INSTALLATION IN BETHEL VALLEY (Costomiris, 1980)

ORNL DWG 81-23564

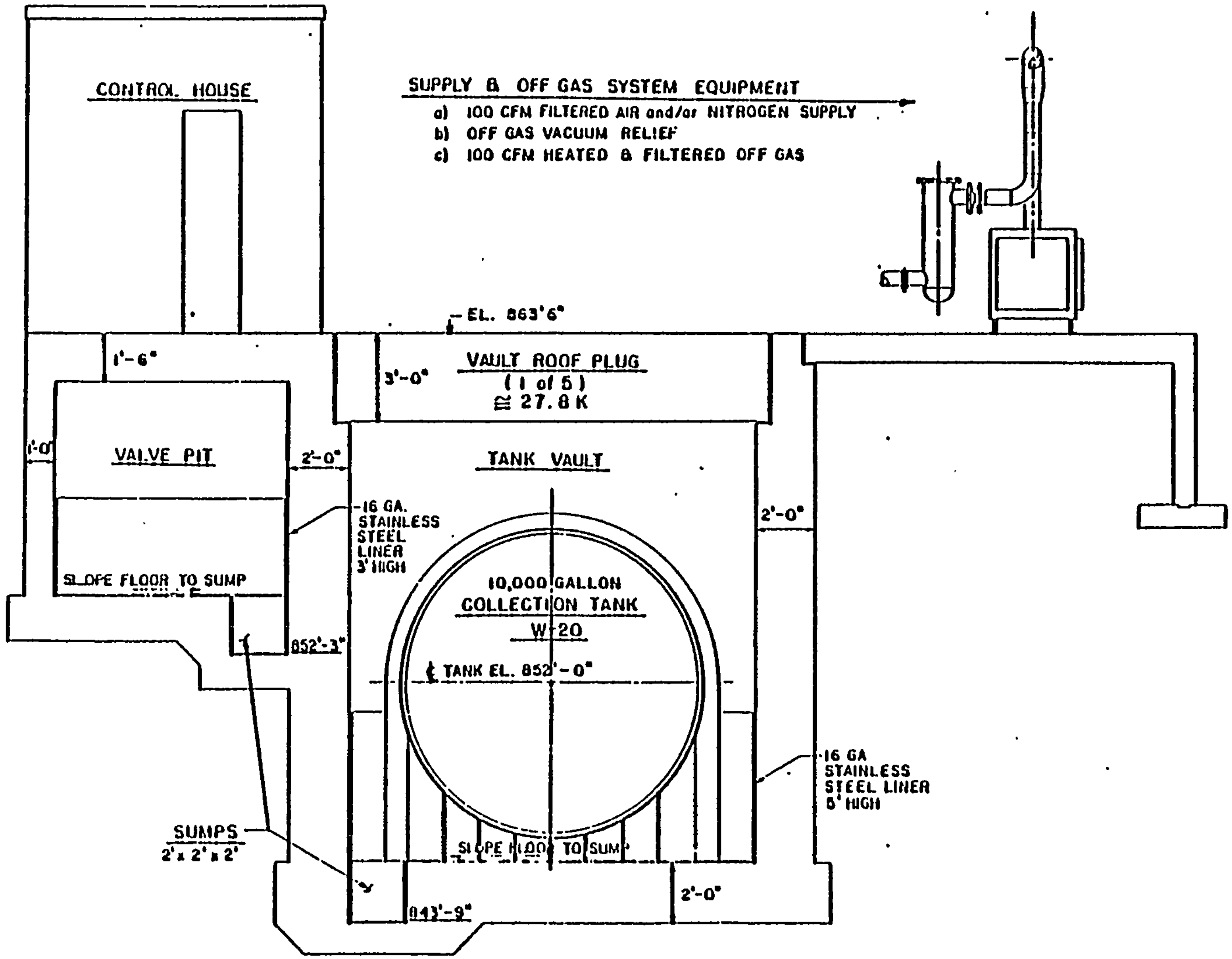


FIGURE A.2-11 TYPICAL NEW COLLECTION TANK (Binford and Orfi, 1978)

ORNL DWG 81-23565

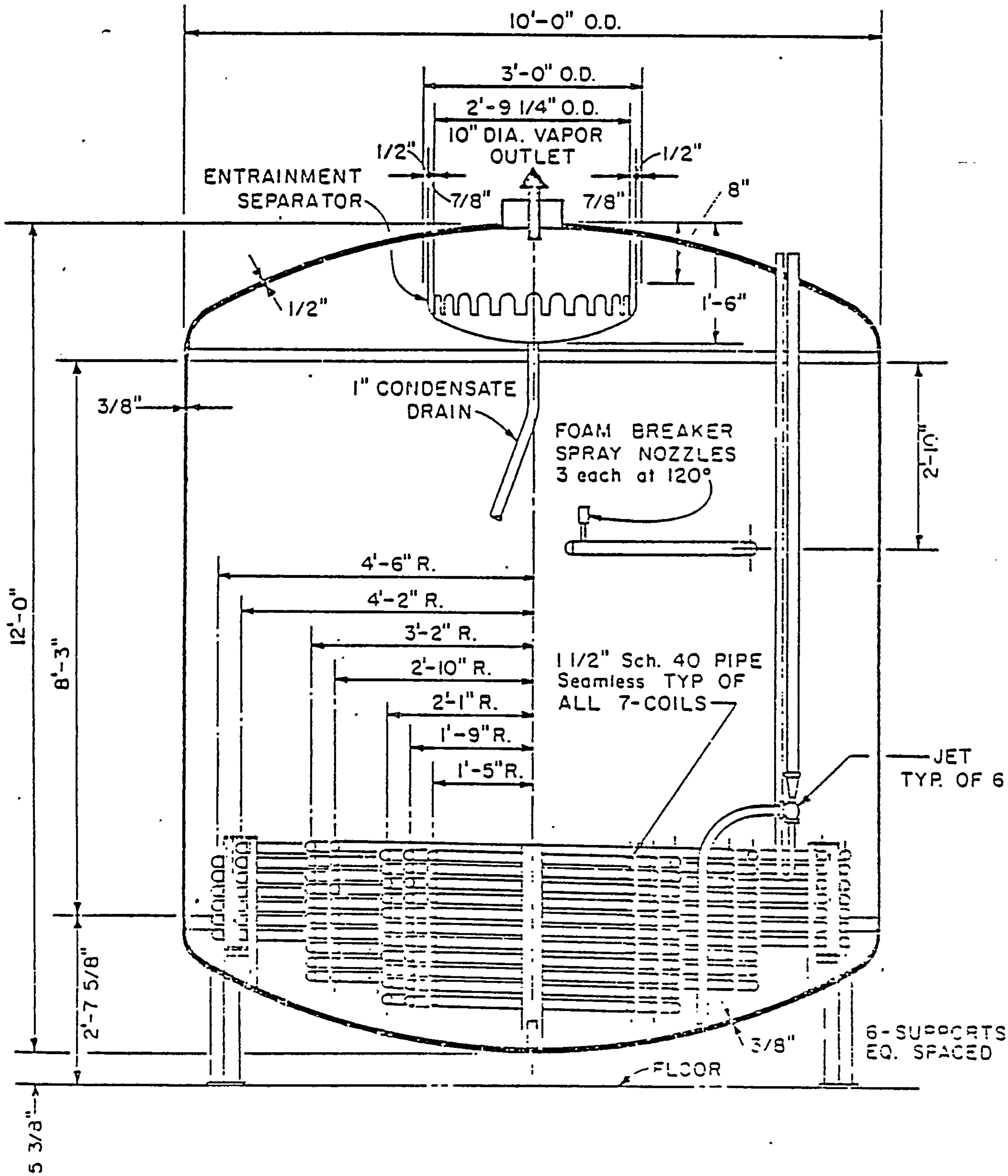


FIGURE A.2-12 SECTION-WASTE EVAPORATOR (Costomiris, 1980)

ORNL DWG 81-23566

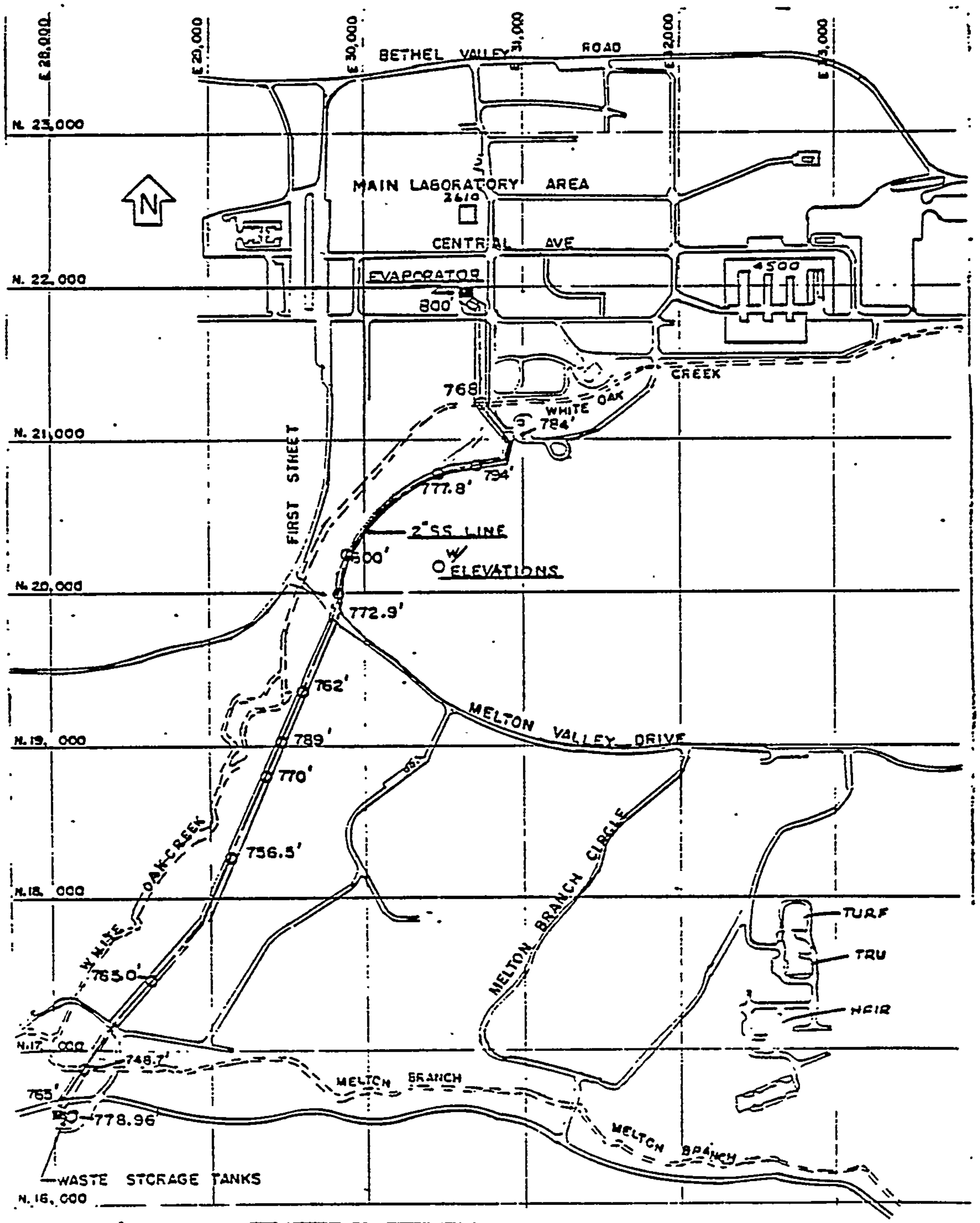


FIGURE A.2-13 EVAPORATOR CONCENTRATE TRANSFER LINE

ORNL DWG 81-23567

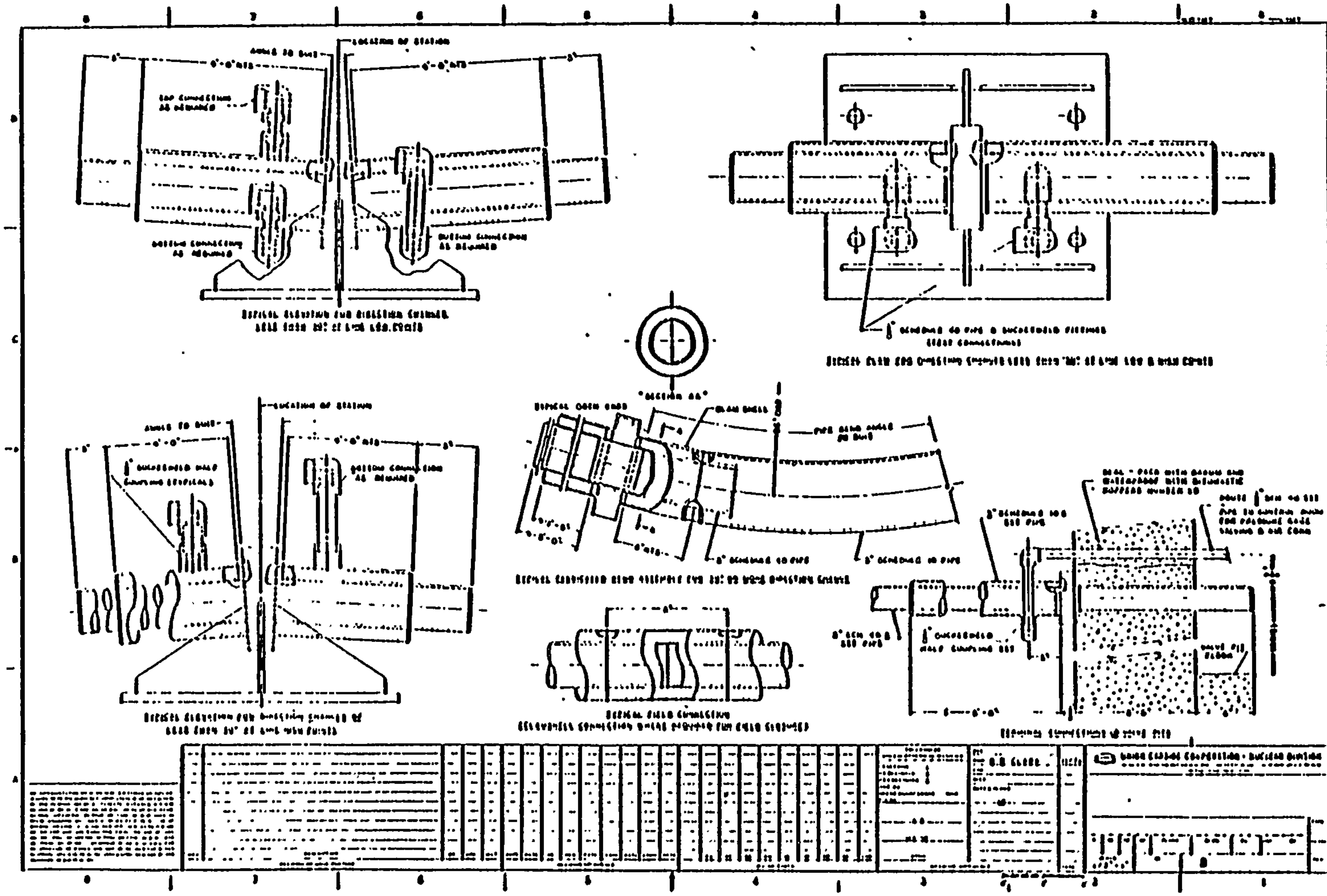
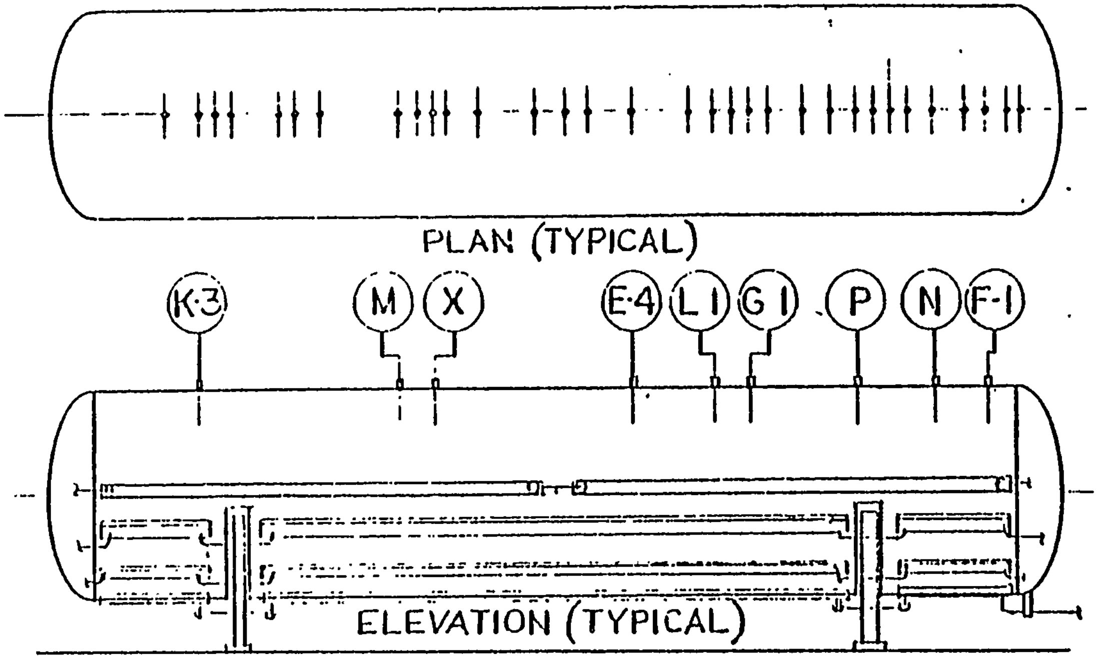
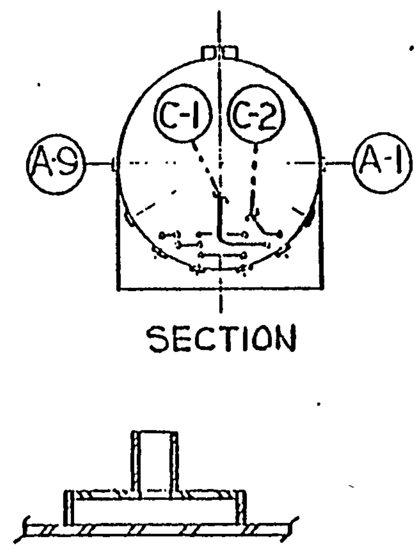


FIGURE A.2-14 TYPICAL DOUBLE-CONTAINED TRANSFER LINE (Binford and Orfi, 1978)

ORNL DWG 81-23568





K3	PROCESS OUTLET (STEAM JET) ONE OF THREE
M	(A) LIQUID LEVEL-LOW PRESSURE
	(B) LIQUID LEVEL-& DENSITY-HIGH PRESSURE
	(C) DENSITY-LOW PRESSURE
X	MANHOLE W/THREE SPARE PROCESS INLETS OF VARYING LENGTH LEGS
E4	(A) AIR SPARGER ONE OF 6 SPARGERS (3 W/THERMO)
	(B) THERMO COUPLE
L-1	(A) SAMPLE SUCTION WITH AIR SUPPLY
	(B) SAMPLE SUCTION WITH AIR SUPPLY
G1	INLET TO INTERNAL COIL (ONE OF TWO)
P	PROCESS INLET (ONE OF EIGHT)+ 1 SPARE
N	VENT
F-1	OUTLET FROM INTERNAL COIL (ONE OF TWO)
A-1	WATER INLET (ONE OF EIGHT) EXTERNAL COOLING JACKET
A-9	WATER OUTLET (ONE OF EIGHT) EXTERNAL COOLING JACKET
C-1	INTERNAL COOLING COIL #1 INLET
C-2	INTERNAL COOLING COIL #2 INLET

FIGURE A.2-15 HIGH-LEVEL WASTE STORAGE TANK (C-1 AND C-2) (Binford and Orfi, 1978)

ORNL DWG 81-23569

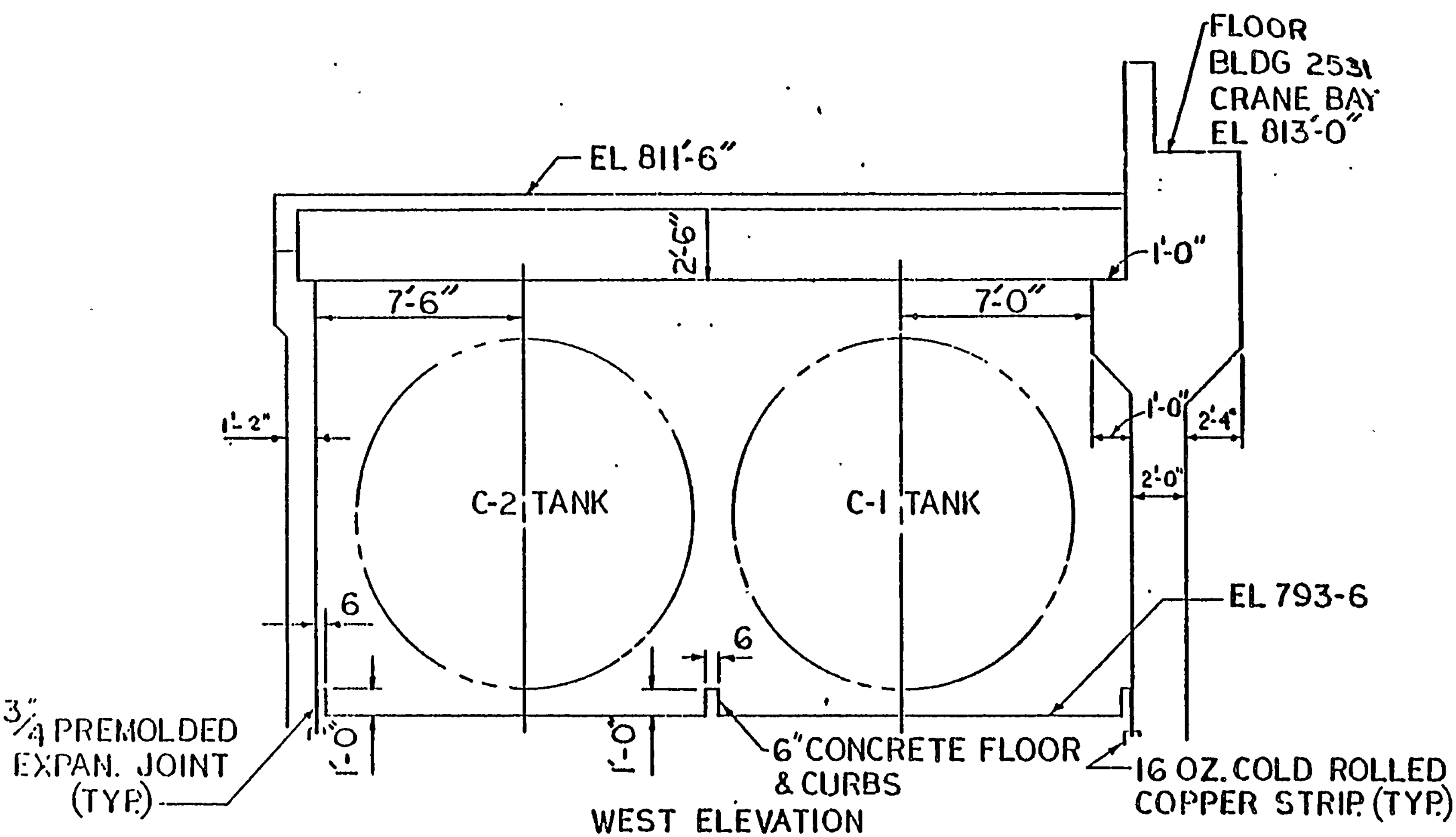


FIGURE A.2-16 HLW STORAGE TANK VAULT ELEVATION (Binford and Orfi, 1978)

ORNL DWG 81-23570

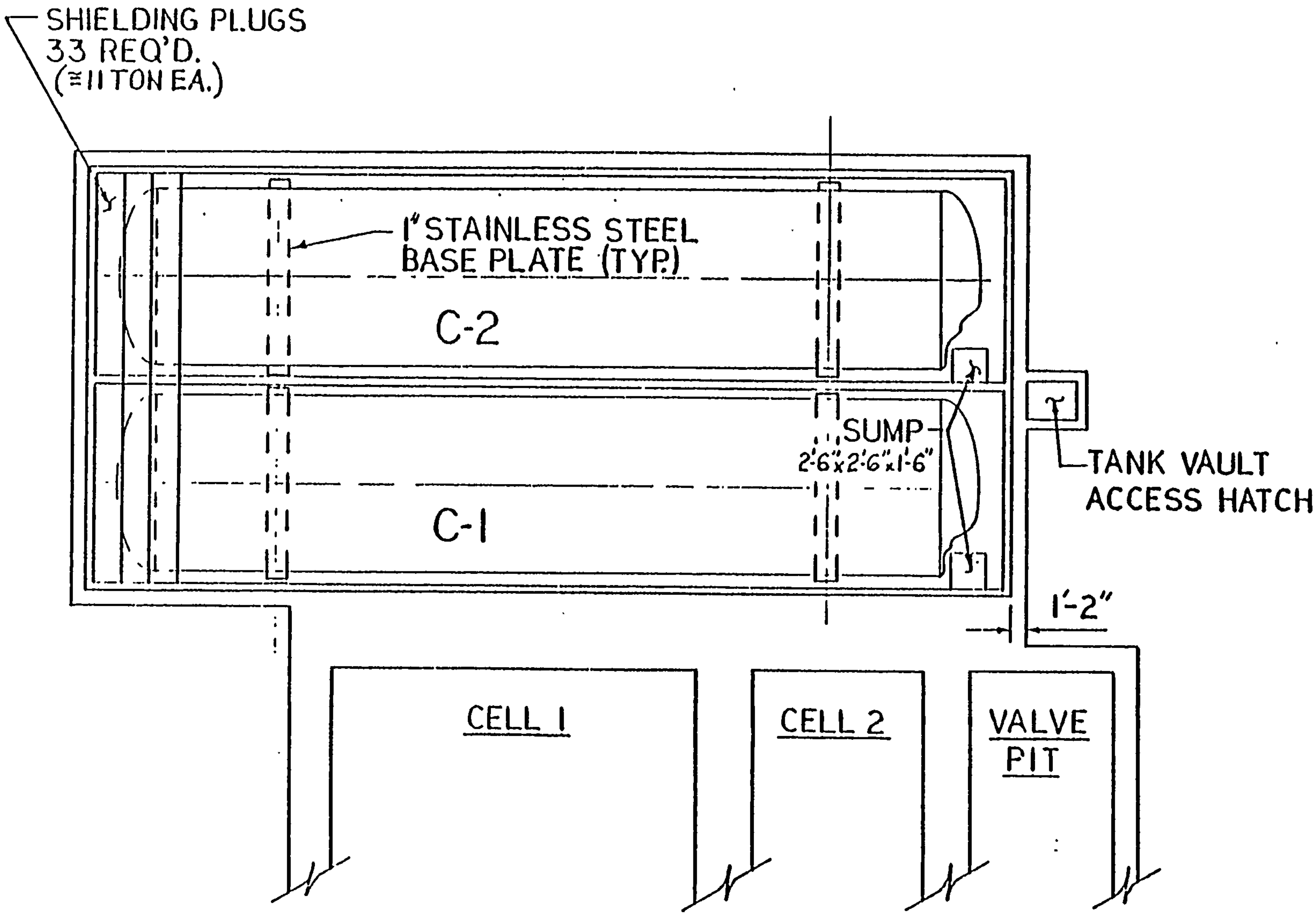


FIGURE A.2-17 HLW STORAGE TANK VAULT PLAN (Binford and Orfi, 1978)

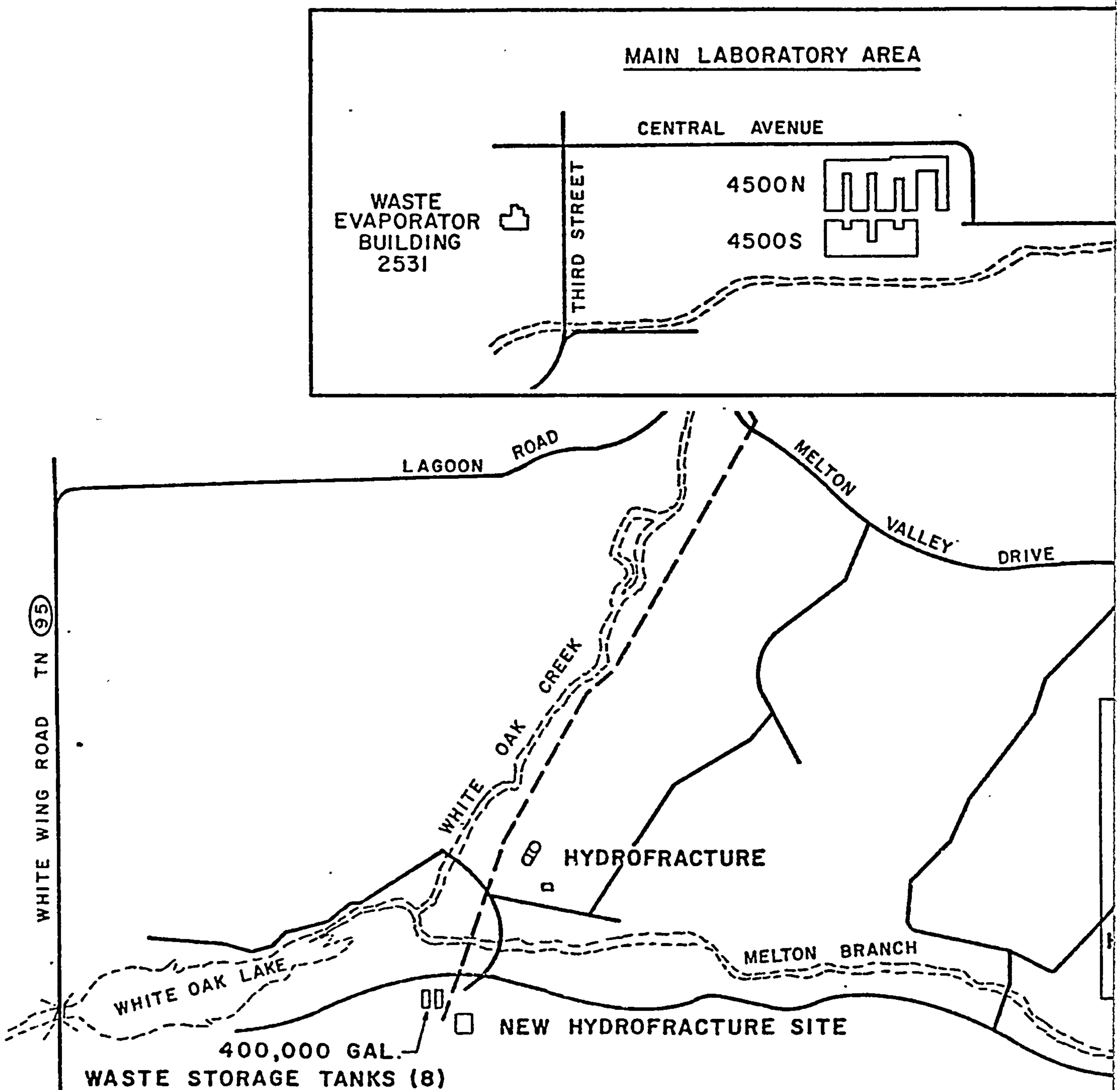
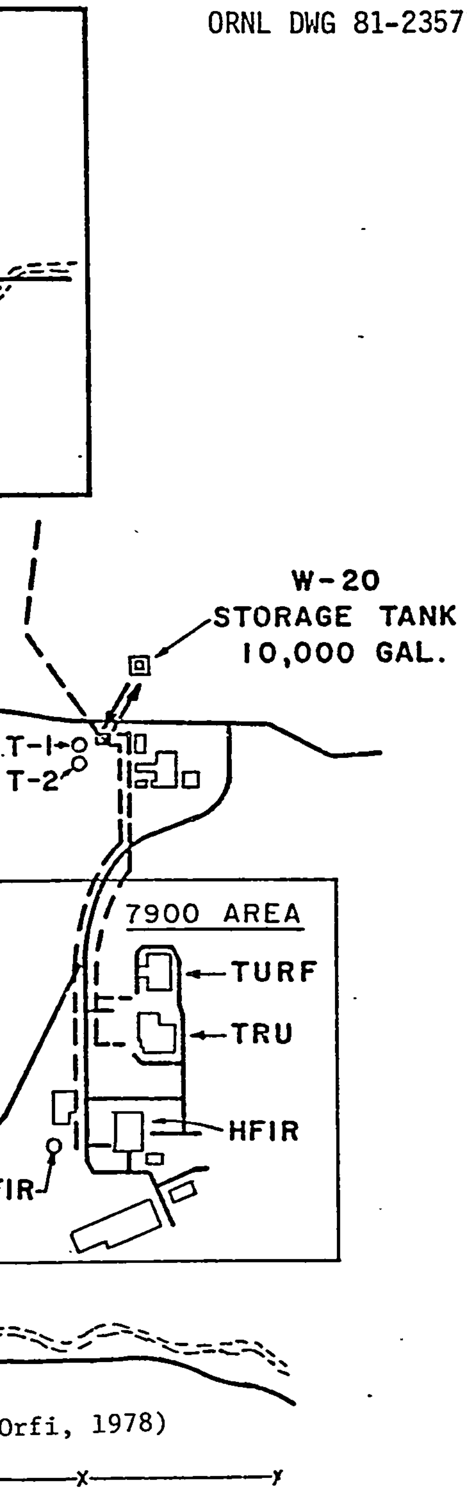


FIGURE A.2-18 LOCATION OF MELTON VALLEY STORAGE TANKS (Binford and

ORNL DWG 81-23571



Orfi, 1978)

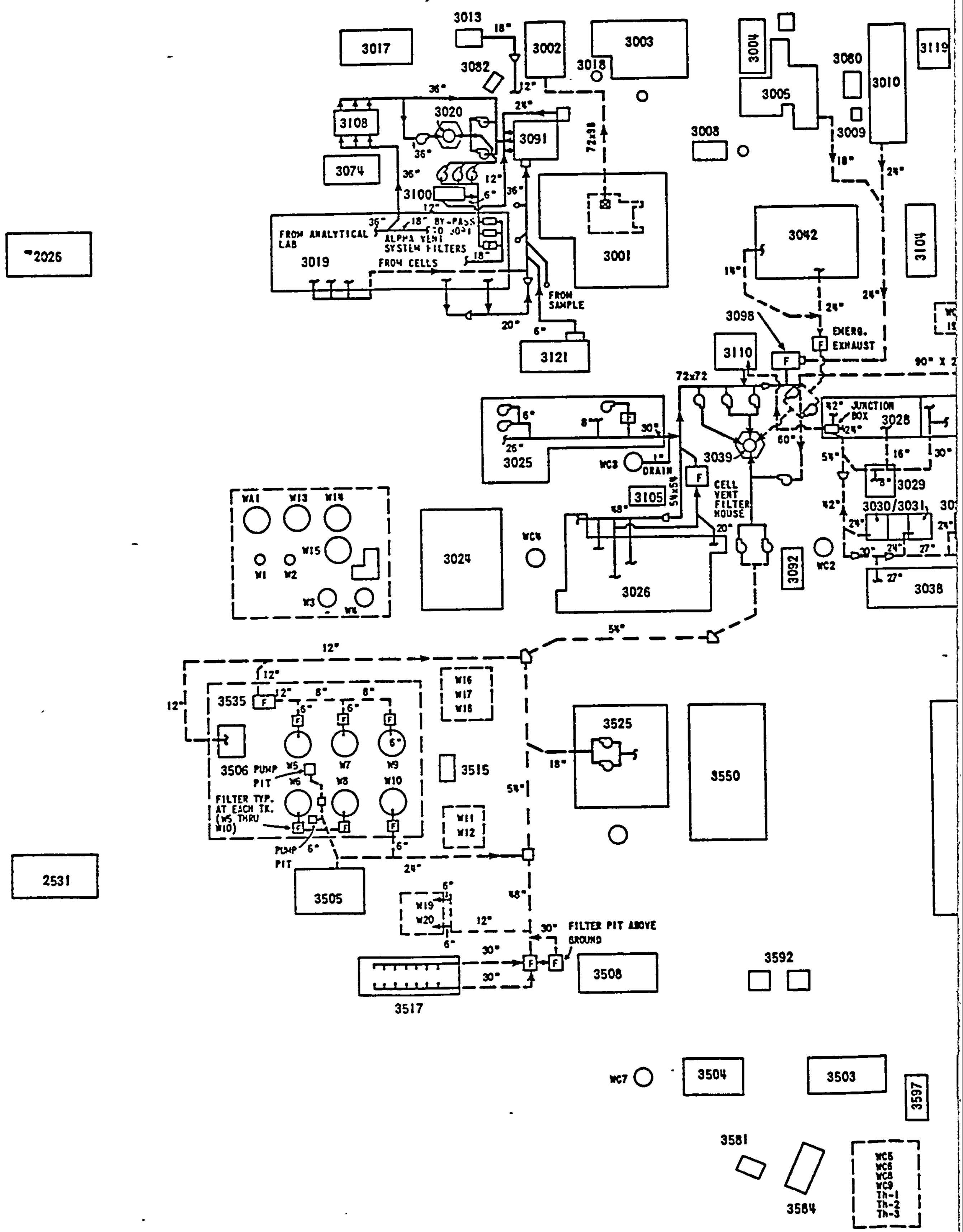
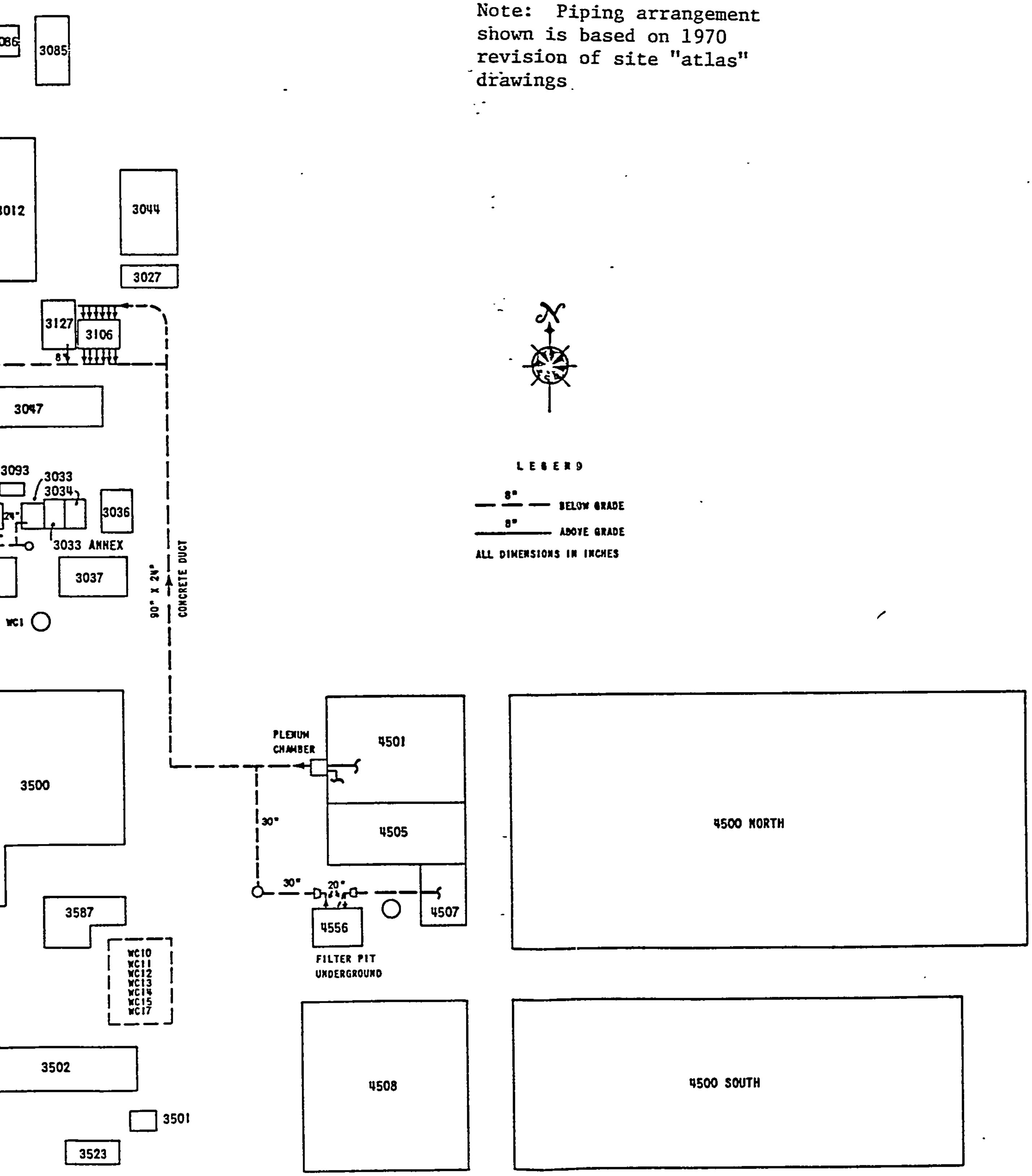


Figure A.2-19 Bethel Valley Cell Ventilation System

ORNL DWG 81-23593

Note: Piping arrangement shown is based on 1970 revision of site "atlas" drawings.



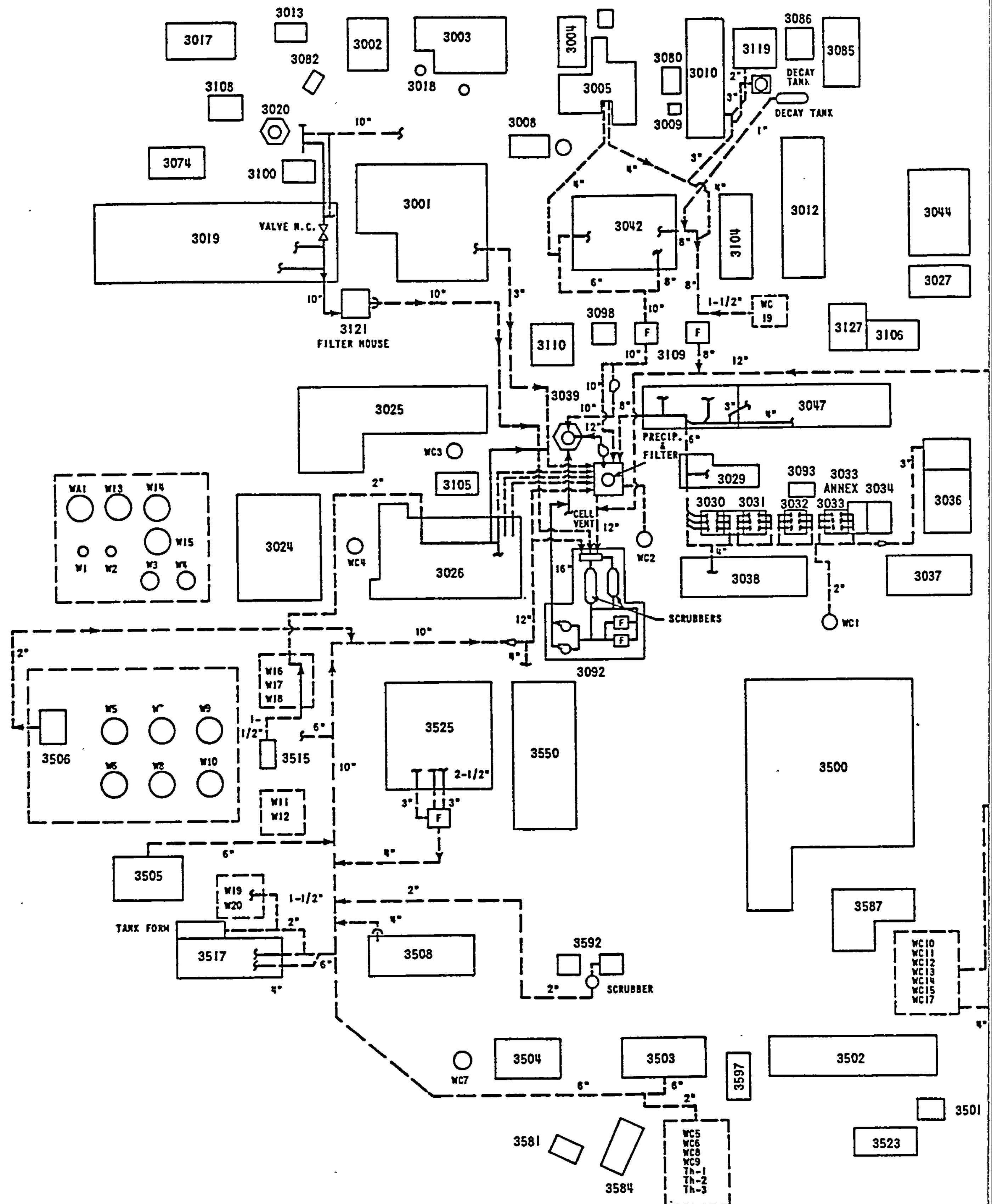
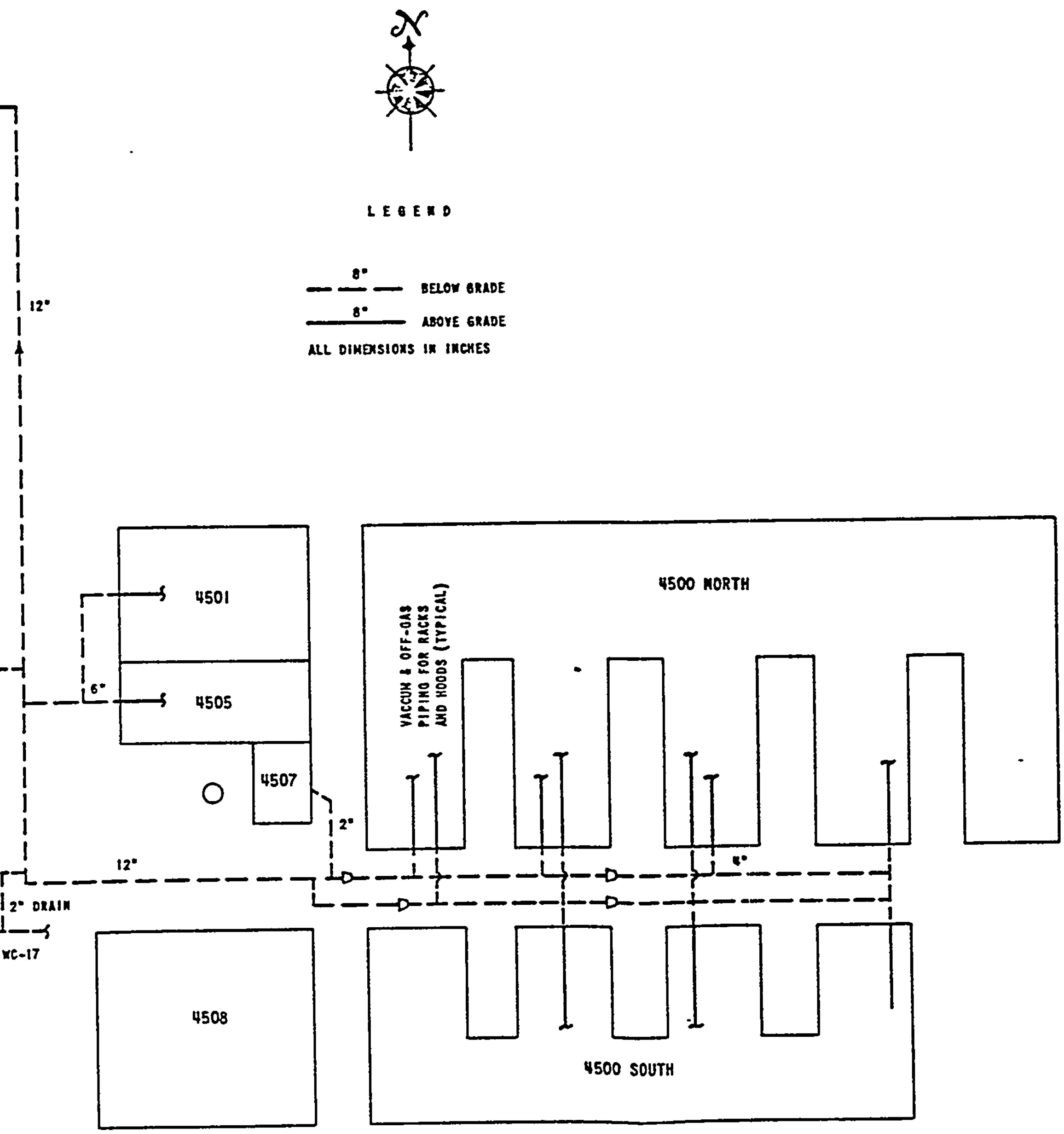


Figure A.2-20 Bethel Valley Off-Gas System (Costomiris, 1980)

ORNL DWG 81-23594

Note: Piping arrangement shown is based on 1970 revision of site "atlas" drawings



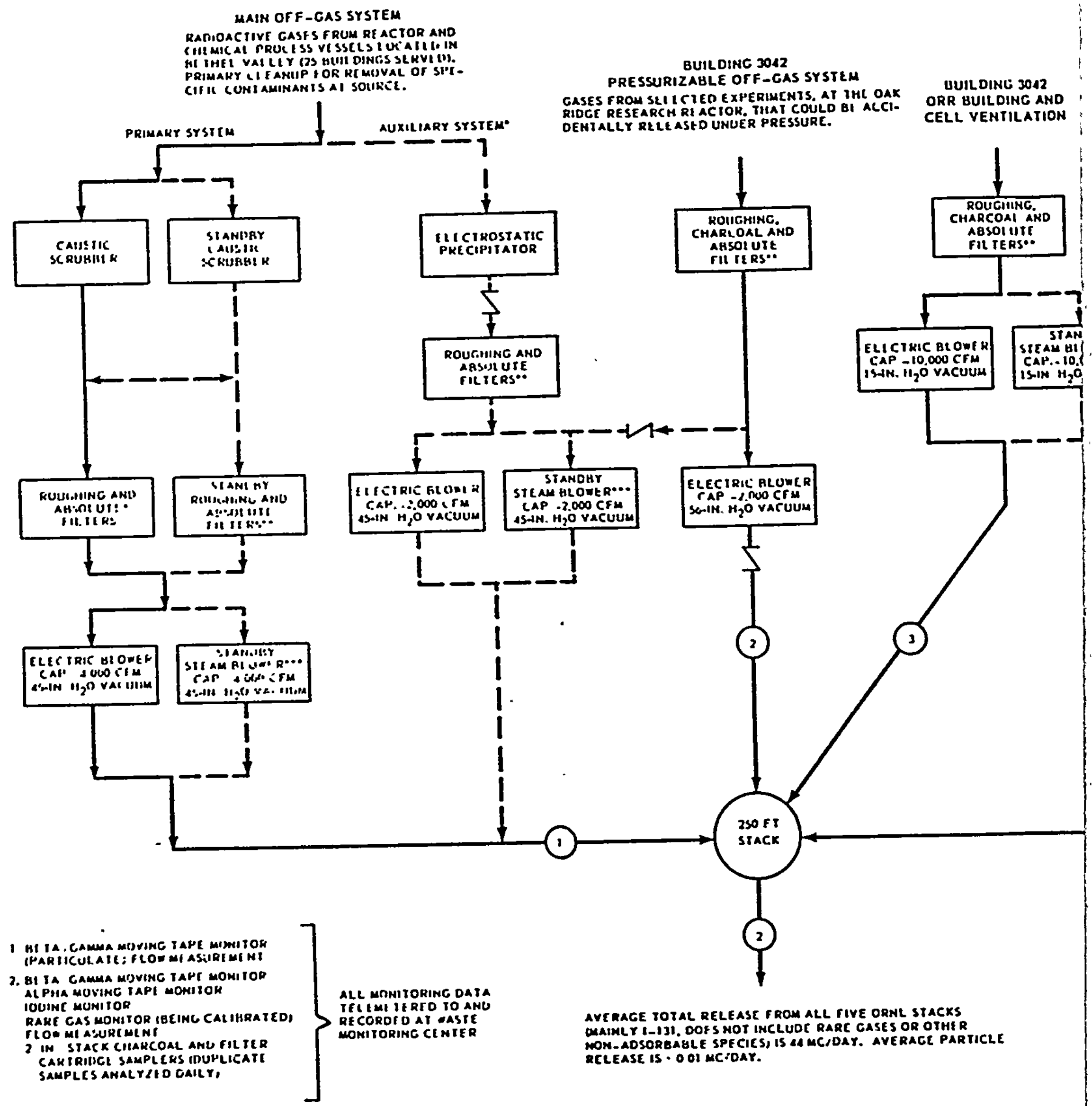
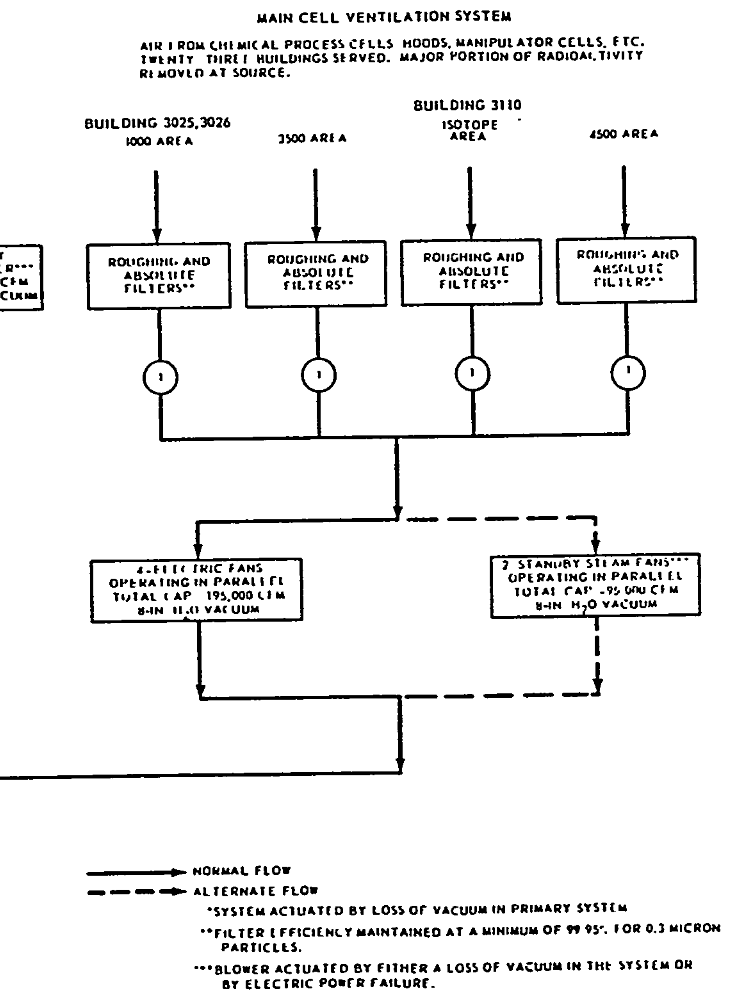


FIGURE A.2-21 CENTRAL GASEOUS WASTE DISPOSAL SYSTE

ORNL DWG 81-23572



3039 STACK AREA (Costomiris, 1980)

ORNL DWG 81-23573

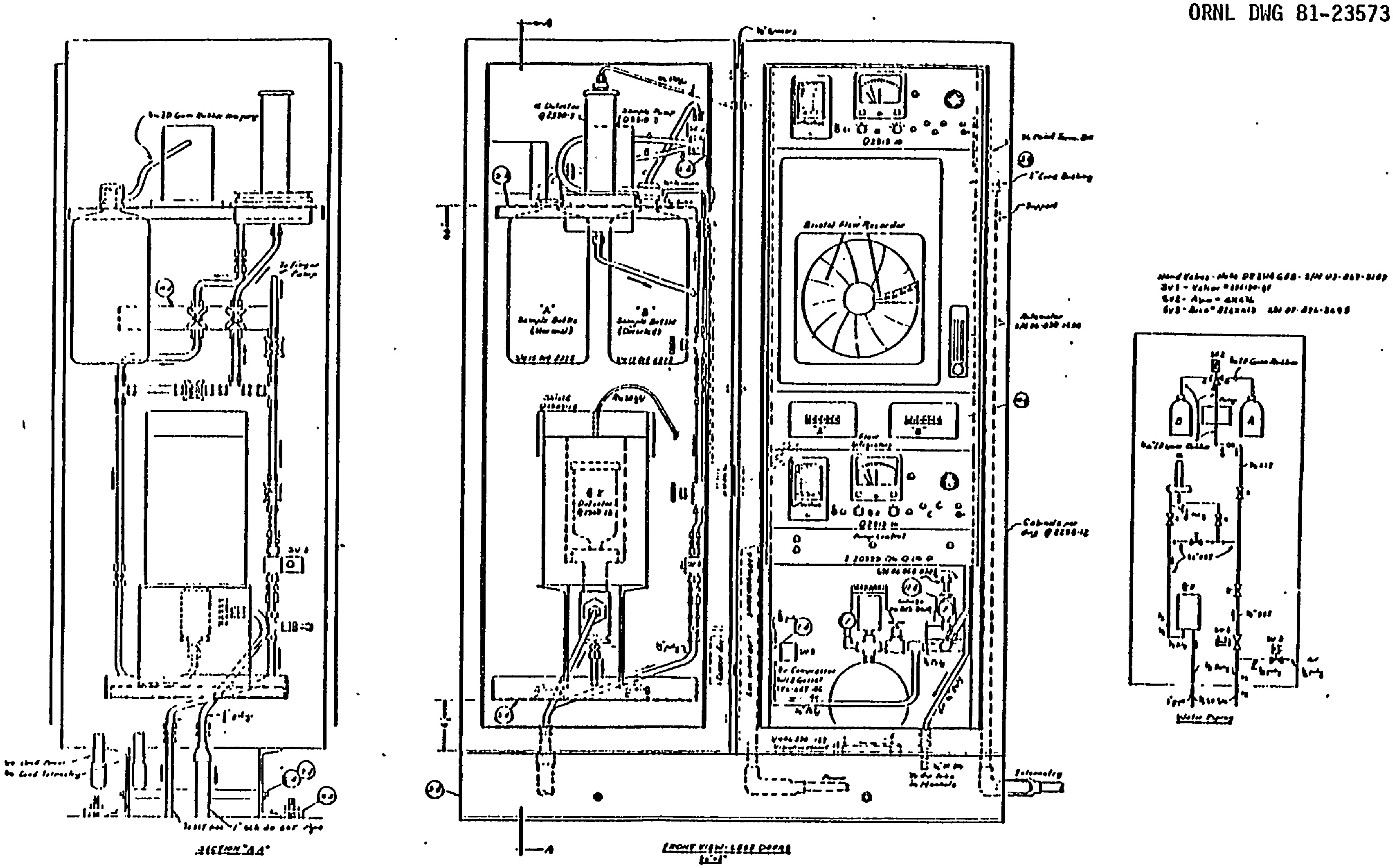


FIGURE A.2-22 ALPHA & BETA-GAMMA INSTRUMENT & SAMPLING CABINETS-ASSEMBLY (Hall, 1970)

ORNL DWG 81-23574

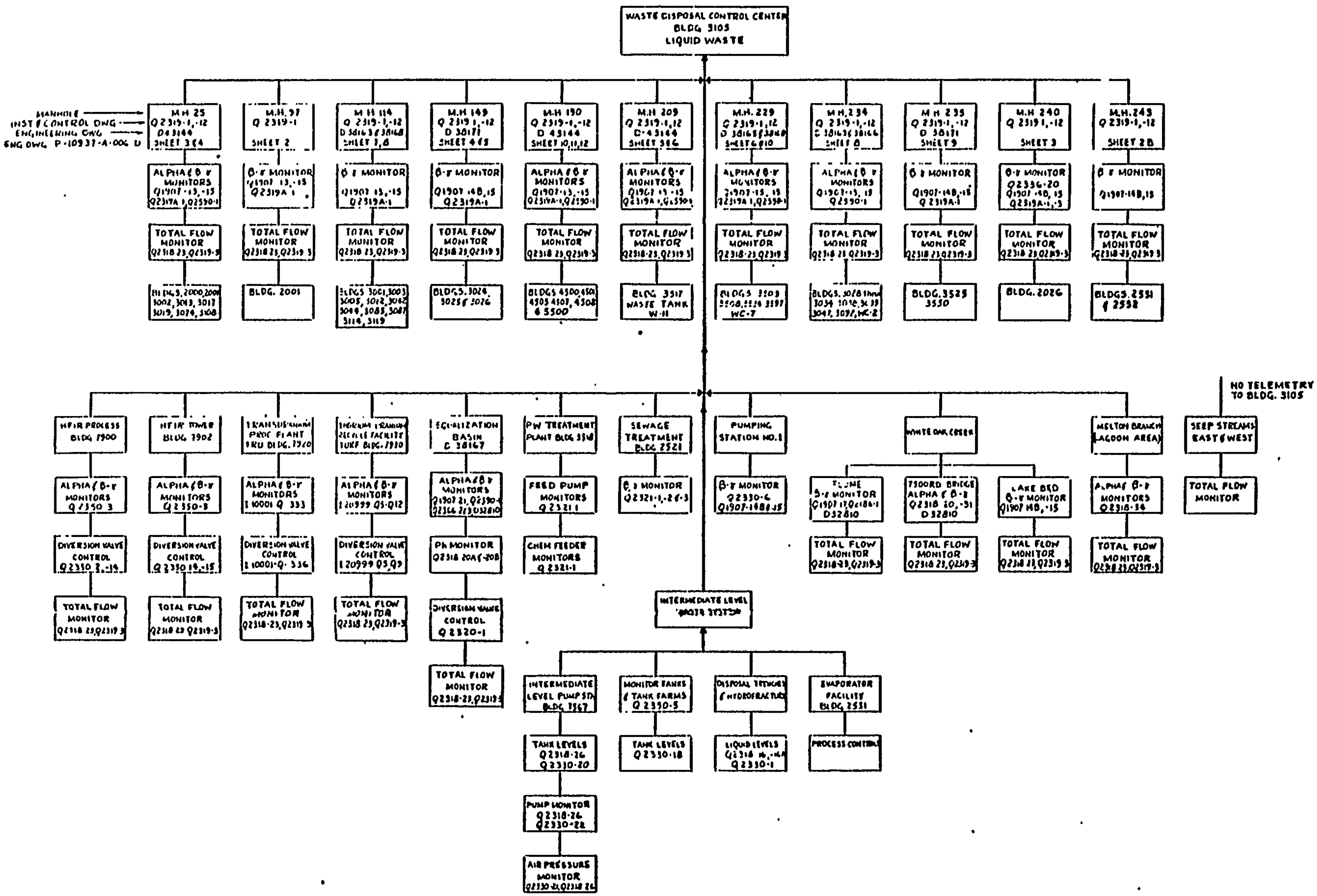


FIG. A.2-23 Drawing Index, Process Waste-Water Waste Disposal Control Center, (Costomiris, 1980)

ORNL DWG 81-23575

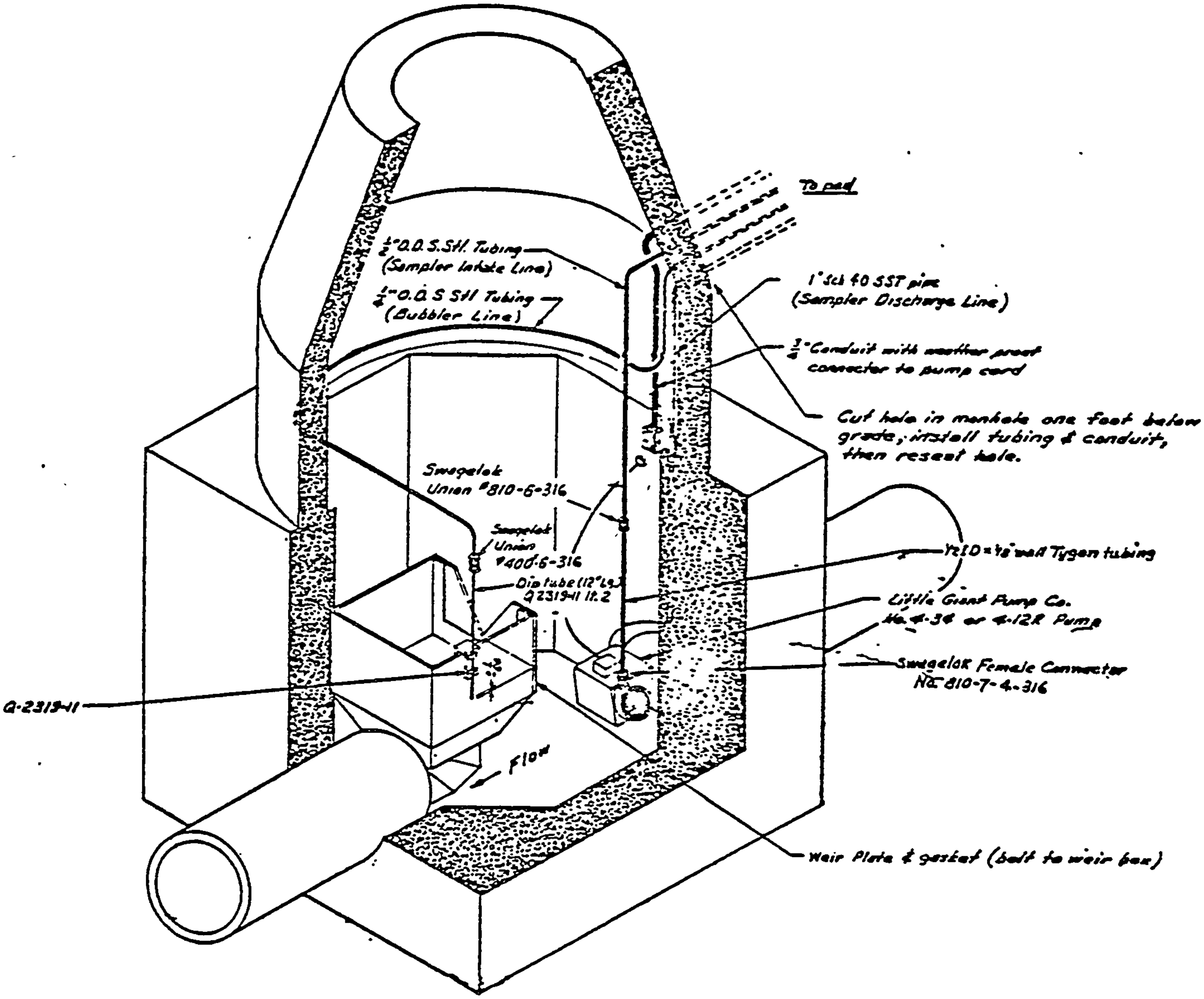


FIGURE A.2-24 TYPICAL MANHOLE WITH WEIR BOX INSTALLATION

(Costomiris, 1980)

ORNL DWG 81-23576

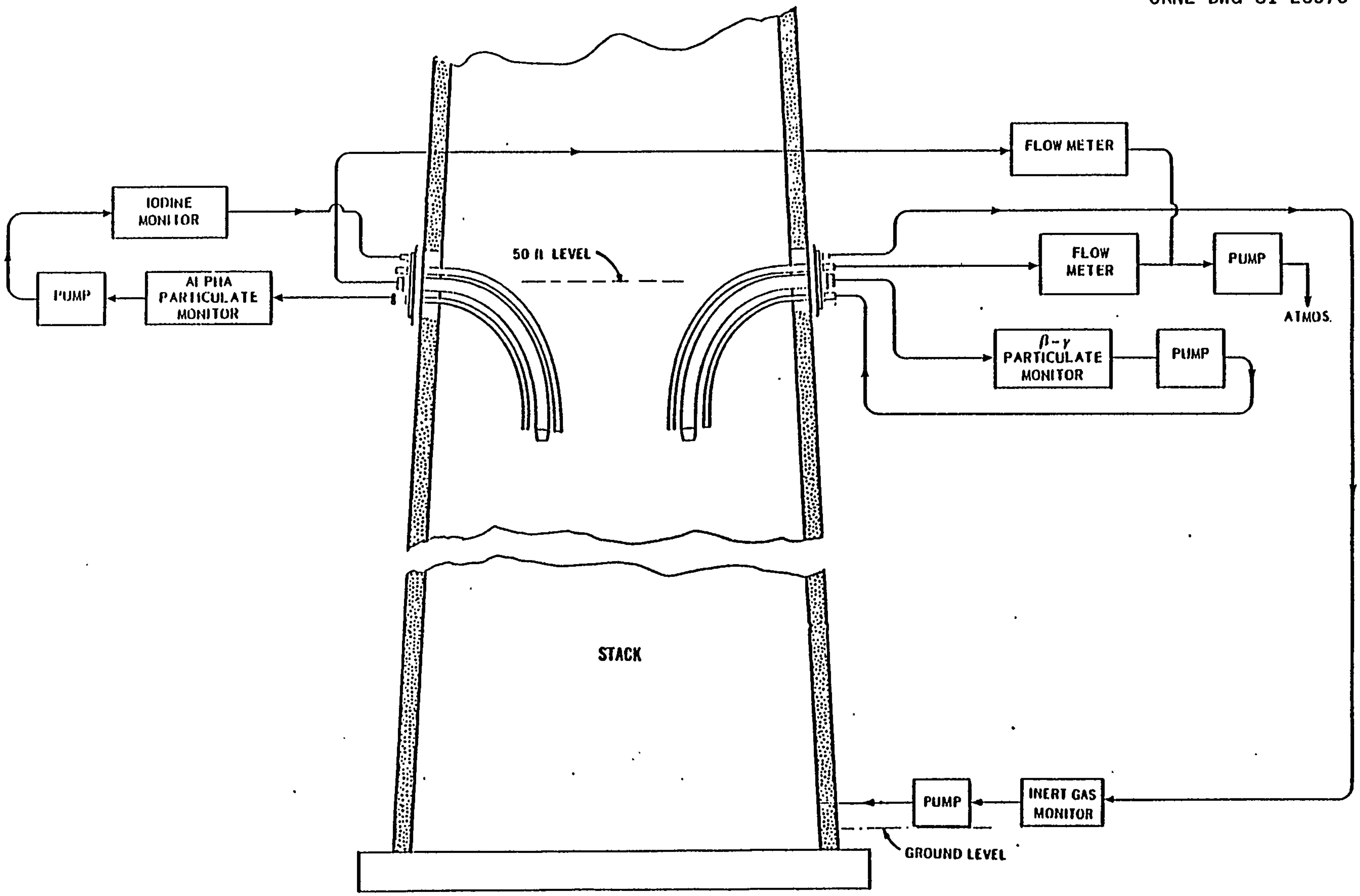


FIGURE A.2-25 3039 STACK MONITOR LOCATIONS (Costomiris, 1980)

ORNL DWG 81-23577

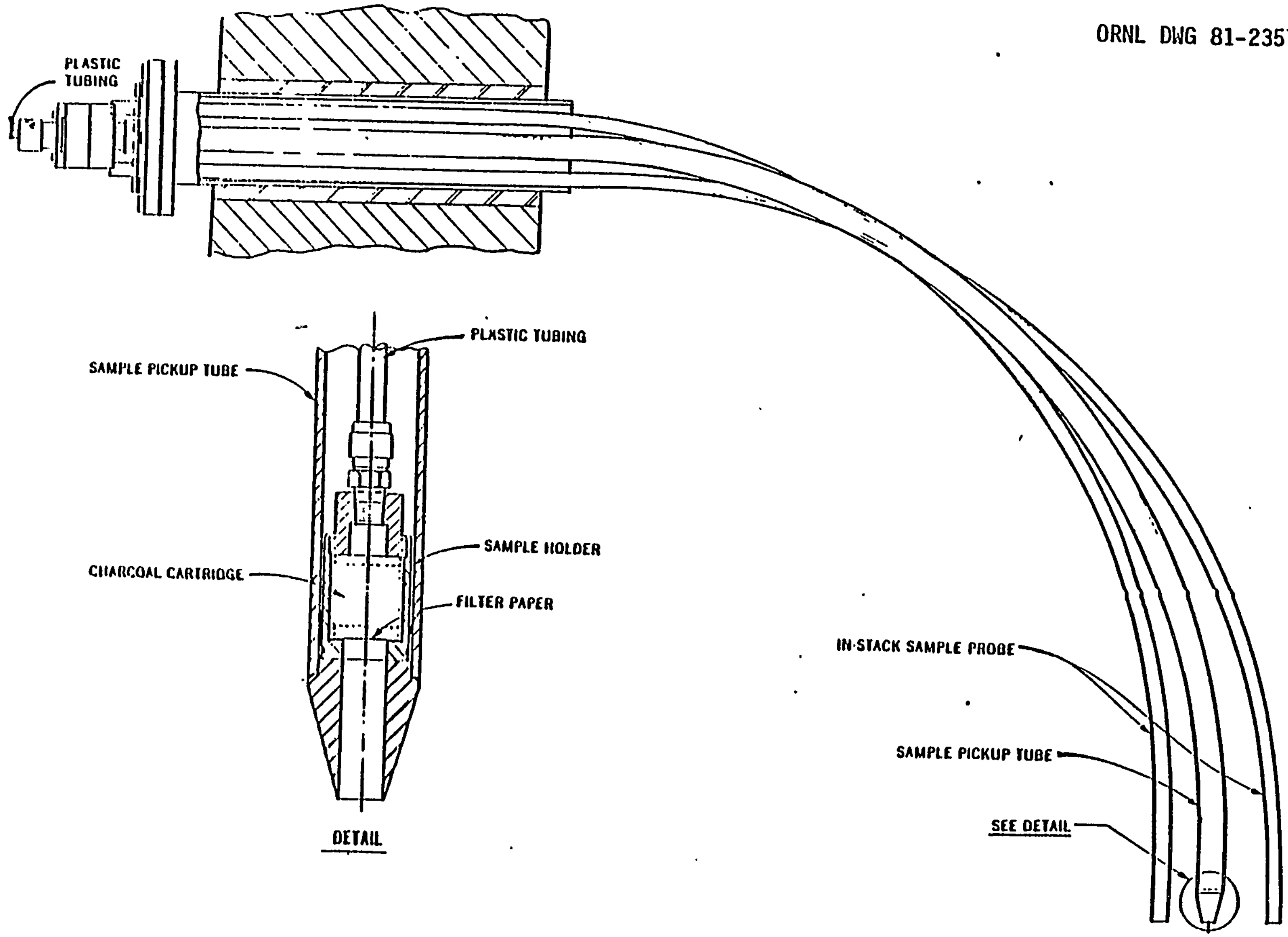


FIGURE A.2-26 IN-STACK SAMPLER ASSEMBLY (Costomiris, 1980)

3.0 ONSITE SRW STORAGE/DISPOSAL ACTIVITIES

3.1 GENERAL

SRW generated at ORNL is collected and packaged in various types of containers and then trucked to solid waste storage areas (SWSA's) for retrievable storage or disposal by means of shallow land burial. If necessary, waste disposed of in this latter manner can also be retrieved, although not without considerable difficulty and expense.

There are six SWSA's at ORNL, located as shown in Figure A.3-1. The burial capacities of SWSA-1, -2, -3, -4 and -5 have been exhausted and these areas are no longer used for shallow land burial. However, one portion of SWSA-5 is still used for retrievable waste storage. SWSA-6 is the only area now used for shallow land burial. At the present rate of waste generation, it too will be filled to capacity in ten more years. In preparation for this eventuality, planning has started for SWSA-7, which will most likely be located in Melton Valley and which is intended to satisfy ORNL's needs for at least the remainder of this century.

From 1955 to 1963, ORNL served as the Southern Regional Burial Ground for low-level SRW. Since 1965, when ORNL ceased to serve in this capacity, very little SRW has been sent there from other sites. Table A.3-1 shows the estimated volume and activity of all waste buried at ORNL since 1943. The drop in both quantity and activity buried after 1965 is very apparent from this table.

For much of the waste buried at ORNL before 1971, little is known about the physical and radiological characteristics. There were no records kept on what was stored in SWSA-1, -2 and -3; and a fire in 1961 destroyed all records of what was stored in SWSA-4 and part of SWSA-5. Since 1971, detailed records have been kept of both the volume and activity content of all waste packages stored in the SWSA's. These are kept in a computerized Solid Waste Information Management System (SWIMS) for ease of retrieval, updating, trend studies, etc.

There are numerous points where SRW from the various generating sources is collected for transport to the SWSA. Initial handling and packaging of the waste before reaching these points is done by the individual waste generators in accordance with procedures developed to protect personnel from exposure and contamination and to ensure that wastes of different categories are properly packaged and labeled. These procedural requirements are outlined in UCC-ND Standard Practice Procedure D-15-15, ORNL Supplement D-5-15 and ORNL Health Physics Manual, Sections 2.3, 4.1 and 5.1.

The following subsections briefly describe the packaging and disposal procedures for each of the various categories of SRW generated at ORNL.

3.2 RETRIEVABLE SRW

At ORNL, only transuranic (TRU) waste is stored retrievably. Transuranic wastes are packaged for storage by the generator and then transported by the SWSA operator to one of the storage facilities as described below.

Transuranic waste (greater than 10 μCi/kg of U-233 or TRU nuclides) reading less than 200 mr/hr on contact is normally packaged in stainless steel 30 or 55-gallon drums by the waste generator. In accordance with the DOE Manual, the waste generator also separates this waste into combustible and non-combustible portions as much as possible before packaging. After drumming and tagging, the waste is taken to a drum staging area (Building 7823) in SWSA-5. After a sufficient number of drums have been collected, they are transferred to the Retrievable Drum Storage Facilities (Buildings 7826 and 7834), which are concrete block structures 85 percent below grade, having storage capacities of 1,536 and 1,920 drums, respectively. To date, approximately 50 percent of the total storage capacity has been used. It is estimated that the remaining 50 percent will be sufficient to satisfy ORNL's needs for at least another 10 years, based on current waste generation rates (Ellis, 1980).

Transuranic waste reading more than 200 mr/hr on contact is normally packaged in reinforced concrete casks by the waste generator. The casks are available in 1.66 m^3 and 0.66 m^3 capacities, having 15.24 cm and 30.48 cm wall thicknesses, respectively. Until 1979, these casks were placed in unlined trenches in SWSA-5, which were then backfilled. This practice was discontinued beginning in 1980, when a concrete, cave-like structure (Building 7855) was commissioned for use in storing these casks. Based on current waste generation rates, this "cave" has enough capacity to handle all waste packaged in casks for at least the next five years. Most of the concrete casks are used to store waste generated in Building 7920. This building is designed to handle only one cask at a time, and for this reason, segregation of the waste in these casks into combustible and non-combustible portions is only done on a limited basis.

Transuranic wastes with very high beta-gamma activity levels are packaged on a case-by-case basis in appropriate containers of various sizes. These containers are then stored in concrete and stainless steel lined wells in Buildings 7827 and 7829 in SWSA-5. These wells are about 2.5 m deep and have diameters ranging from 20.3 cm to 76.2 cm. The storage capacities of the wells range from 0.1 m^3 to 1.1 m^3. The walls are closed with 1.0 m thick concrete plugs.

U-235 wastes are packaged in containers appropriate for the physical characteristics of the waste and then placed (buried non-retrievably) in unlined auger holes in SWSA-6, which are then backfilled and capped with concrete. The generator of this type of waste is required to limit the amount of U-235 per container to 200 gm, unless special exemption from this limit is granted by the Criticality Committee.

3.3 NONRETRIEVABLE SRW

Nonretrievable, general catagory SRW falls into one of four groups. These are: a) high-level (greater than 200 mr/hr); b) compactible low-level (less than 200 mr/hr); c) non-compactible low-level; and d) low hazard contaminated waste.

General category waste reading greater than 200 mr/hr is packaged by the waste generator in suitable containers (plastic bags, cans, etc.), tagged for identification and then placed in shielded dumpsters, shielded casks or shielded "hot" trucks. Once filled, these are transported to SWSA-6, where their contents are emptied into trenches or unlined auger holes. A typical disposal trench is shown in Figure A.3-2. These trenches are limited to a maximum length of 15.25 m and maximum width of 3 m. Depth is usually 3 to 4.5 m and is always at least 0.6 m above the existing groundwater level. The trenches are sloped toward one end, and a 15.25 cm diameter perforated pipe extends vertically to the bottom of the lower end of the trench to serve as a monitoring well. Ditches are provided around the trenches to direct surface water away from the trenches. Appropriate barriers are placed around the open portion of a trench for personnel safety. After the trenches have been filled with waste and covered with a layer of native soil, they are seeded for control of erosion. For long term care of the filled trenches, periodic ground-water monitoring and vegetation control are required.

General SRW that is compactible and that reads less than 200 mr/hr is packaged by the waste generator in various types of containers that are suitable for compaction. These packages (plastic bags, cardboard boxes, thin metal cans, etc.) are tagged, recorded and placed in specially marked yellow dumpsters located in convenient locations near the waste generators. After the dumpsters are filled, they are taken to SWSA-5, where the contents are removed and compacted in a baling machine located in Building 7831. The baling machine produces bales of waste in rectangular cardboard boxes measuring 50.8 x 76.2 x 101.6 cm (0.425 m^3), weighing 305 kg and bound by four metal straps. The baled waste is then transported to SWSA-6 for disposal in trenches as described above.

The waste baler has been in operation since 1978. In its first year of operation, the baler processed 383 m^3 of waste, reducing its volume by a factor of nine. Compactible waste normally accounts for about 20 percent of the total amount of general category SRW produced. Therefore, considering all general category waste disposed of by shallow land burial, use of this baler results in a net VR factor of approximately 1.3.

General low-level SRW waste that is not compactible is packaged by the generator in containers that will prevent spillage or the spread of contamination while handling the packages. Typical packages are plastic bags, trash cans and paper boxes. These are tagged and collected in specially marked yellow dumpsters located near the generators. After a dumpster is full, it is transported to SWSA-6, where the contents is disposed of in burial trenches as described above.

Low hazard waste is comprised of general trash that has no measurable contamination by radiation survey but is judged by the generator, because of its history, to be radioactively contaminated above "green tag" limits and hence unsuitable for release from Waste Management Operations Control. This waste is collected in regular trash dumpsters or trucks and transported to SWDA-6 where it is disposed of by conventional land fill methods.

TABLE A.3-1

TOTAL ANNUAL ACTIVITY, VOLUME, AND WEIGHT OF SOLID WASTE BURIED OR STORED

Fiscal Year	Activity, Ci	Volume, ft^3	Weight, lb
43	2.0×10^3	2.5×10^4	3.0×10^5
44	2.0×10^3	2.5×10^4	3.0×10^5
45	2.0×10^3	2.5×10^4	3.0×10^5
46	2.0×10^3	2.6×10^4	3.0×10^5
47	1.0×10^4	1.4×10^5	2.0×10^6
48	1.0×10^4	1.4×10^5	2.0×10^6
49	1.0×10^4	1.4×10^5	2.0×10^6
50	1.0×10^4	1.4×10^5	2.0×10^6
51	1.0×10^4	1.4×10^5	2.0×10^6
52	1.0×10^4	2.0×10^5	2.0×10^6
53	1.0×10^4	2.0×10^5	2.0×10^6
54	1.0×10^4	2.0×10^5	2.0×10^6
55	1.0×10^4	2.0×10^5	2.0×10^6
56	1.0×10^4	2.0×10^5	2.0×10^6
57	2.0×10^4	3.2×10^5	4.0×10^6
58	2.0×10^4	3.2×10^5	4.0×10^6
59	2.0×10^4	3.2×10^5	4.0×10^6
60	2.0×10^4	3.2×10^5	4.0×10^6
61	4.0×10^4	5.31×10^5	6.0×10^6
62	3.0×10^4	4.24×10^5	5.0×10^6
63	2.0×10^4	3.33×10^5	4.0×10^6
64	2.0×10^4	3.21×10^5	4.0×10^6
65	1.0×10^4	1.89×10^5	2.0×10^6
66	1.0×10^4	1.59×10^5	2.0×10^6
67	1.0×10^4	1.99×10^5	2.0×10^6
68	2.0×10^4	2.42×10^5	3.0×10^6
69	1.0×10^4	1.92×10^5	2.0×10^6
70	1.0×10^4	1.28×10^5	1.0×10^6
71	1.1×10^4	1.67×10^5	2.29×10^6
72	1.0×10^4	1.29×10^5	1.90×10^6
73	9.0×10^3	1.07×10^5	1.57×10^6
74	8.8×10^3	1.20×10^5	1.55×10^6
75	2.0×10^3	1.12×10^5	1.41×10^6
76 (1)	1.1×10^4	1.25×10^5	1.49×10^6
77 (2)	2.0×10^4	7.77×10^4	6.67×10^5
78	5.25×10^3	8.32×10^4	9.24×10^5
79	5.65×10^4	7.03×10^4	1.3×10^6
80	6.03×10^4	7.45×10^4	1.25×10^6

NOTES:

1. July 1, 1975 through September 30, 1976 - Reflects change in fiscal year to begin in October.

2. Data obtained from Costomiris, 1980 and personnel correspondence with E. King.

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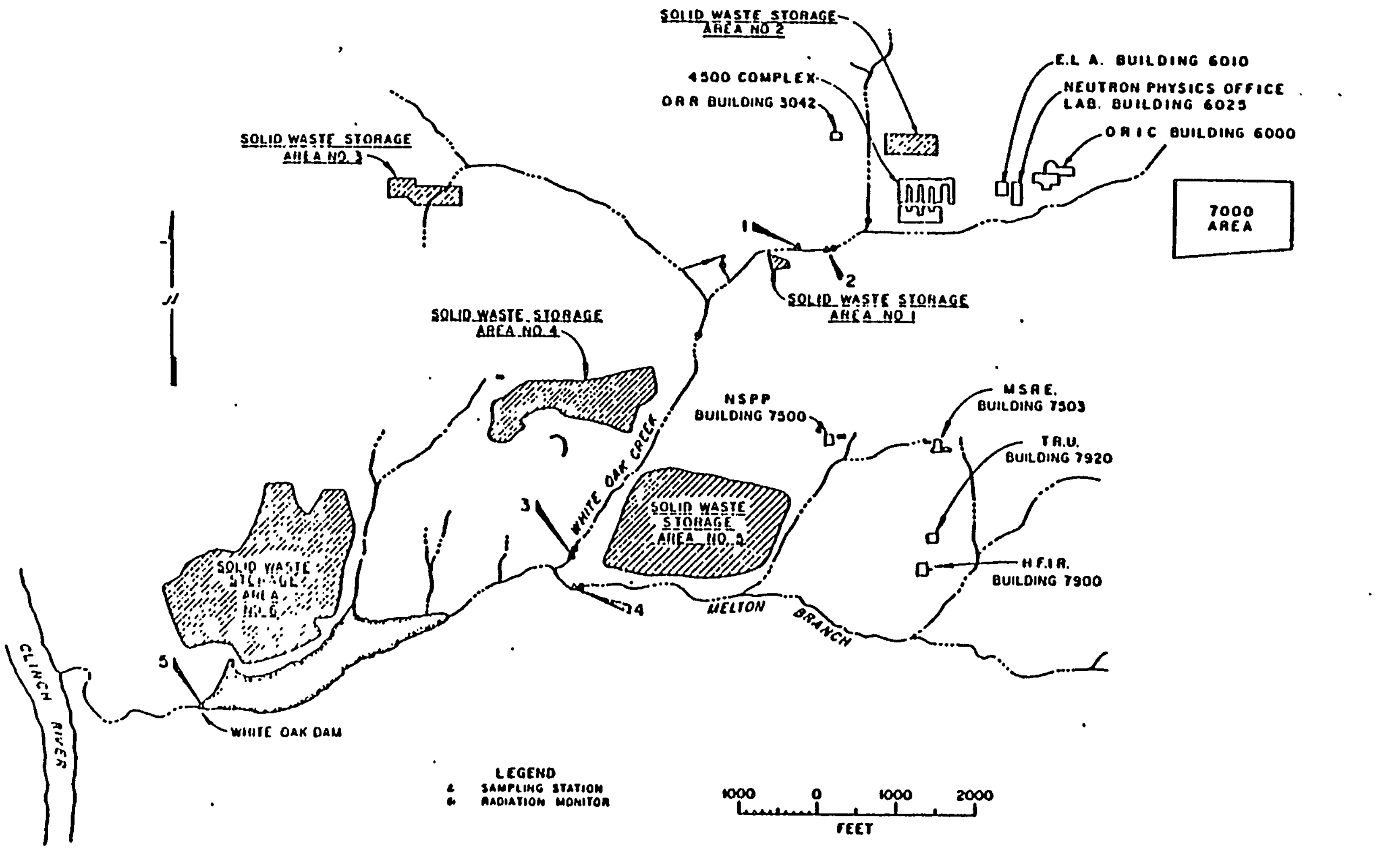


FIGURE A.3-1. LOCATION PLAN OF ORNL SOLID WASTE STORAGE AREAS (Binford and Gissel, 1975)

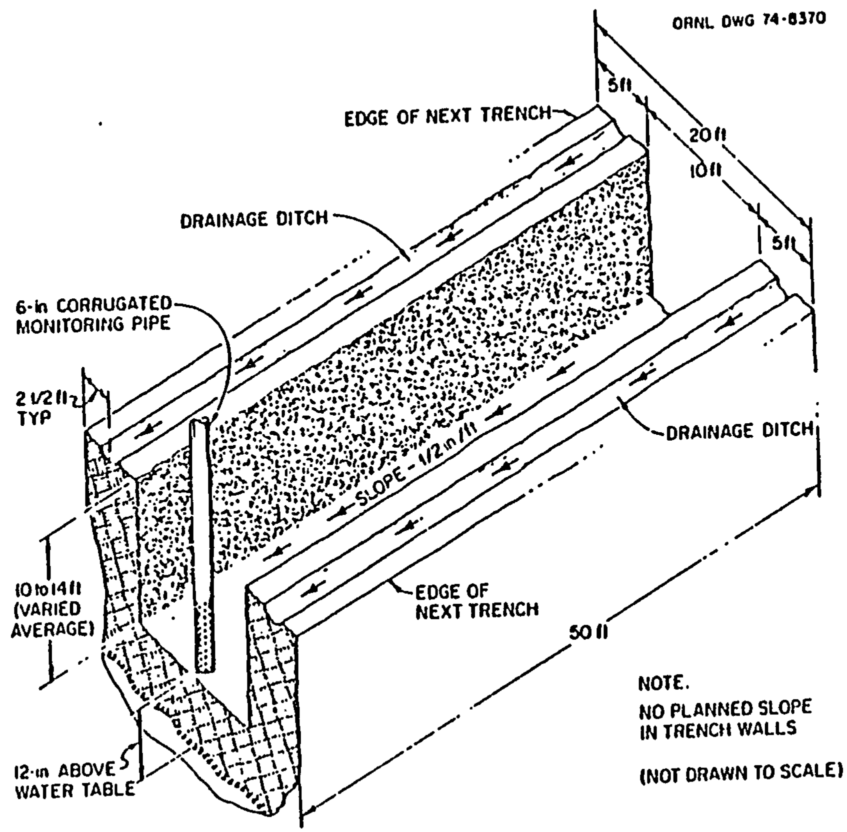


FIGURE A.3-2 TYPICAL SWSA DISPOSAL TRENCH LAYOUT Binford and Gissel, 1975.

APPENDIX B

ASSESSMENT OF EXISTING WASTE MANAGEMENT PRACTICES/FACILITIES

APPENDIX B

ASSESSMENT OF EXISTING WASTE MANAGEMENT PRACTICES/FACILITIES

1.0 APPLICABLE REGULATIONS

Radioactive waste management operations at ORNL are governed principally by the Department of Energy Administrative Manual requirements and the immediate action directives (IAD) issued to provide more specific regulatory implementation guidance. In addition the requirements of numerous regulatory agencies at the Federal, State and local level would be involved in issuing any permits and approvals necessary to implement most of the recommended radwaste improvement projects discussed in detail in Appendix B.3.0. The specific considerations of all of these regulatory requirements is beyond the scope of this study. However, those Federal agencies whose activities represent a lead or major interface have been considered. These include: a) the Department of Energy (DOE), b) Environmental Protection Agency (EPA), and c) Nuclear Regulatory Commission (NRC). A discussion of the roles of these agencies and their effect on ORNL operating policy are briefly discussed below. Questions concerning regulatory compliance issues are discussed in greater detail in Appendix B.3.0 along with specific recommendations for the approaches to be considered in achieving compliance with pertinent requirements and guidelines.

DOE: DOE offices, field organizations and contractors are required to conduct their operations in accordance with Manual Chapters originally issued by the Atomic Energy Commission and adopted by DOE upon its formation. The Manual Chapters that are judged to be the most relevant to the activities considered in this study are 0511, 0513, 0524, 0530 and 0531. ORNL routinely conducts its operations in accordance with the requirements of these chapters as directed by DOE.

Chapter 0511, "Radioactive Waste Management," requires: a) conduct of operations and disposal and storage of radioactive waste in a manner to assure that present and future radiation exposures will be at the lowest levels technically and

and economically practicable; b) continuing efforts to develop and use improved technology for reducing radioactive releases; and c) minimization of the extent and degree of contamination of land by waste management activities.

Chapter 0513, "Effluent and Environmental Monitoring and Reporting," requires an evalaution of on-site discharges, liquids and gaseous effluents, and the immediate environment to assess the radioactive and nonradioactive pollutant levels for: a) compliance with applicable federal policies, standards and requirements; b) determining the adequacy of effluent control, environmental protection, and efforts to achieve levels of radioactivity which are as low as practical.

Chapter 0524, "Standards for Radiation Protection," provides guidance for radiation protection in normal and accident situations. This chapter sets numerical standards for doses and concentrations of radioactivity that result from DOE and contractor activities.

Chapter 0531, "Safety of Nonreactor Nuclear Facilities," contains provisions for assuring that environmental protection and health and safety matters are adequately addressed for nonreactor nuclear facilities and that all identifiable risks are reduced to as low a level as practicable. This chapter includes guidelines for the establishment of Environmental Safety and Health Programs.

<u>EPA</u>: The EPA does not directly regulate radioactive waste management activities at ONRL; however, various EPA requirements indirectly affect many operational practices. Manual Chapter 0510 specifies the requirements for air and water pollution control. Radioactive effluents are exempted by the Atomic Energy Act and are controlled in accordance with Chapter 0524. Although radwaste effluents are exempt, non-radioactive or other hazardous components of waste streams are not and are regulated via various state and EPA standards. For example, under Chapter 0510, "Prevention Control and Abatement of Air and Water Pollution," ORNL operations would have to comply with the Hazardous Waste Management Facility Program of the Resource Conversation and Recovery Act, the Underground Injection Control Program of the Safe Drinking Water Act and the National Pollutant Discharge Elimination System of the Clean Water Act. In addition EPA has

published general environmental protection criteria that are intended to represent a uniform national policy generally applicable to all types of radioactive wastes and management practices (Federal Register, 1978 and USEPA, 1978). In view of the complex and changing nature of the regulatory environment governing ORNL operations, it is apparent that, in terms of long range planning for radwaste facilities and operational improvements, a conservative compliance posture toward environmental protection is the most prudent course of action.

NRC: Radwaste management activities at ORNL are not under the licensing jurisdiction of the NRC. However, it has been the general policy of ORNL to comply to the extent practical with all reasonable regulatory requirements issued by this agency and to interact with and support the NRC in many research and policy areas. A study recently undertaken by the NRC, (NUREG-0527, 1979), at the direction of Congress, assessed the possible extension of NRC licensing authority to include categories of existing and future Federal radioactive waste storage and disposal activities. This direction by Congress reflects a desire to achieve a uniform national policy for radioactive waste management. If this extension of NRC licensing and regulatory authority were to occur, numerous modifications to ORNL radwaste management operations would be required (Appendix B.3.0). ORNL's radwaste improvement planning efforts should reflect a position of ultimate compliance with NRC requirements to the extend that they are consistent with DOE policy. All the same ORNL's radwaste management leadership role in terms of national policy formation, imposes a responsibility to devise and develop better waste management practices taking into account all aspects of the problem. Their roles need to be balanced in a very sensitive and judicious manner.

2.0 PROBLEM AREA PRIORITIZATION CRITERIA

In developing a radioactive waste management improvements program plan for ORNL operations, a major consideration should be the criteria to be used for prioritizing problem areas so that scheduling and budgeting can be accomplished for each major improvement project. Because the improvements program plan eventually approved by ORNL will take into account factors beyond the power of this document to predict or control (such as the results of negotiations with state and Federal government agencies over interpretation and implementation of their regulations; availability of funds; and the impact of national security interests), it is not feasible (practically speaking) for this document to recommend the numerical order in which these projects ought to be carried out. In lieu of this, criteria have been developed to enable ORNL planners to be able to classify all major problem areas and associated improvement projects under one of three major levels of importance, as defined in the following subsections.

2.1 PRIORITY LEVEL I CRITERIA

Priority Level I areas are those for which improvements or corrective actions are deemed essential and for which the recommended improvements program should be implemented immediately. Examples of items in this category are:

A. Conditions that are cause for concern either because of their immediate and serious effects on the environment and/or the health and safety of workers or the general public, or because they do not meet current regulatory requirements.

B. Practices that, although permitted by exception, are not now consistent with present or impending rules or regulations governing operations at ORNL.

C. Conditions for which corrective measures have been approved and funded as line items or operating budget expenses.

D. Practices or procedures which, if not modified relatively soon, could with a high degree of certainty develop into major problems.

E. R&D necessary to either implement improvement projects for the above areas of concern or to assess the validity of the advantages claimed for these projects.

2.2 PRIORITY LEVEL II CRITERIA

Conditions considered as Priority Level II are those for which corrective actions or improvements are also considered essential. However, the nature of these conditions are such that corrective action or improvements can be delayed somewhat to accommodate funding and scheduling requirements for Priority Level I items. Included under this category are the following:

A. Conditions that are a cause for future concern because of their potential long-term adverse effect on the environment and/or the health and safety of workers or the general public.

B. Conditions for which there is a possible, though uncertain, chance of immediate or future adverse effects on the environment and/or the health and safety of workers or the general public, but for which further data and study are needed to verify the validity of the concerns or to determine the corrective measures which need to be taken.

C. Infrequent and/or unexpected abnormalities (tank spills, transfer line failures, flooding/high water table, gaseous release spikes, etc.) which would have a significant adverse effect on the environment and/or the health and safety of workers and/or the general public; and for which reasonable improvements could be made that would have a high probability of mitigating these adverse effects.

D. Conditions which, if corrected or improved, could result in substantial reductions in the volume of waste generated and/or stored and/or disposed.

E. Conditions which, if corrected or improved, could result in substantial reductions in the overall costs of processing and/or storage and/or disposal of radioactive wastes.

F. R&D projects which would help satisfy ORNL's commitments to providing leadership in developing systems that could substantially improve the economics of managing radioactive wastes, lessen the environmental impact of radioactive wastes produced by the nuclear industry, or improve the health and safety aspects of processing and disposal of radioactive wastes.

2.3 PRIORITY LEVEL III CRITERIA

Priority Level III conditions are those for which improvements are not required to be pursued now, but for which improvement programs merit consideration, either because of the potential these improvements have for providing net long-term social or economic benefit or because of the possibility that it might become necessary to pursue these improvements in the future to comply with anticipated regulatory changes. Included under this category are the following:

A. System conditions for which recommended improvement plans would bring ORNL's radwaste management program in line with those of the commercial nuclear power industry, where these latter practices are deemed to provide a higher benefit/cost ratio with regard to the health and safety of the workers and general public, and/or protection of the environment. Specifically, this would involve those areas where the NRC's rules and regulations for handling and disposal of radioactive materials are more restrictive than those of the DOE.

B. System conditions for which the recommended improvements are of marginal or questionable benefit now, but which could result in justifiable economic and/or health and safety and/or environmental benefits under different operational or regulatory conditions (e.g., installation of an incinerator if ORNL were to become a regional depository for low-level wastes from the commercial nuclear power industry).

C. R&D of a long-range nature necessary to ensure that for Priority Level III situations, improvement projects that are being considered for implementation will achieve the corrective measures anticipated.

3.0 RECOMMENDED IMPROVEMENTS

In this section, a detailed description is given of each area where there is a need for improvement in system design and/or operation. For each situation, background information is presented, the reasoning for assigning a particular priority level to the item is discussed, and recommended actions to improve the current conditions are put forth. Where appropriate, estimates are also given of the schedule duration and cost or manhours associated with particular recommendations. The cost data presented here serves as the basis for the cost summary presented in Section 4.2.

As was done in the summary in Section 2.3, the recommendations presented here are organized under five basic categories of waste management. For convenience in cross-referencing, these recommendations are also presented in the same order in which they appear in Table 2.3-1 of Section 2.3.

3.1 SOLID RADIOACTIVE WASTE (SRW) MANAGEMENT

3.1.1 Low-Level SRW Processing/Disposal

3.1.1.1 Discussion

As described in Appendix A, 3.0, shallow land burial has been used as the primary means for disposal of low-level SRW at ORNL since the facility opened in 1943. Approximately 2×10^5 M^3 of SRW, containing approximately 4.8×10^5 Ci of activity, have been disposed of in this manner through September 30, 1979 (Costomiris 1980). There are two interrelated concerns associated with this practice. One of these is the uncontrolled release of radioactive material to the environment via leachate from the burial grounds. The other is the amount of land usage required by shallow land burial, which is accentuated by the geological/hydrological conditions existing at ORNL. These concerns are discussed in detail below:

This section of the report deals only with SRW disposed of by means of shallow land burial. A review of ORNL's procedures and facilities for handling retrievable TRU contaminated waste (ELLIS, 1980 has concluded that present practices for handling these wastes are satisfactory from a safety standpoint for an interim onsite storage period of 20 years, or longer. Therefore, for the purposes of the present five to ten year look ahead effort, no additional work has been identified in the area of retrievable TRU waste management. As noted in the referenced work by Ellis, plans should eventually be made for retrieving this waste and repackaging as necessary for shipment to a Federal repository. At present, there are no firm plans for the location of such repositories, nor are the requirements for packaging of the wastes finalized. Acceptance criteria for wastes to be shipped to the Waste Isolation Pilot Plant in southeastern New Mexico have been developed (Irby, 1980), but it is not clear at this point whether or not ORNL's TRU wastes will be sent to this facility or to some other, as yet, undefined site. In either case, it appears that these packaging criteria could be met at the time the waste is retrieved from its present storage facilities in preparation for this trip. Considering this fact and the degree of uncertainty still surrounding the ultimate disposition of these wastes, it is G/C's opinion that ORNL should continue its present packaging/storage methods while assuming a wait-and-see attitude with regard to DOE plans for final disposition of this waste material.

1. Leaching of Radionuclides from Burial Grounds

For the first six months of 1979, the <u>uncontrolled</u> amount of Sr-90 released into White Oak Lake was 1.58 Ci, which was 95 percent of the total amount released during that period (Costomiris, 1980). As shown in Figure A.1-2, the total yearly amount of Sr-89/Sr-90 released by all ORNL sources to White Oak Lake dating back to 1965 has varied considerably, ranging from a high of 10.2 Ci in 1974 to a low of 2.2 Ci in 1978. At present, this situation does not represent a safety hazard because the concentration after dilution in the Clinch River is less than one percent of MPC values for even the 10.2 Ci release in 1974. However, for reasons as discussed below, releases may not be ALARA in all cases.

Chapter 0511 of the DOE Manual states, in part, that "continuing efforts shall be made to develop and use improved technology for reducing the radioactivity releases to the lowest technically and economically practical level." However, DOE gives no quantitative guidelines for determining what a "practical" lower limit is. In contrast, for reactor facilities under the regulatory jurisdiction of the NRC, Appendix I of Title 10 CFR 50, gives specific values for use in judging whether or not the facility is meeting ALARA criteria.

Figure A.1-1 indicates that there has been a steady downward trend in the total amount of activity released to the environment via liquid discharges, and for the past three years, it appears that ORNL would even satisfy the very conservative release criteria applicable only to commercial LWR facilities. On this basis, then, it would appear that ORNL's current releases are ALARA. However, consideration should be given to the following factors that may affect the ORNL situation:

- Monthly release reports are based on readings at the outfall of White Oak Dam. However, releases are known to have occurred in the past via at least one additional pathway (that being Racoon Creek). There is also a possibility that some unmonitored activity could reach the Clinch River from SWSA 6 via groundwater entering an unidentified creek running parallel to White Wing Road northwest of this storage area. All such additional releases must be considered when evaluating compliance with ALARA criteria.

- Waste Management Operations' monthly release reports give only the total beta activity released into the environment. Reports on the amount of gamma activity being released were not provided for inclusion in this assessment, but must also be considered, since allowable limits should include total beta-gamma releases, not just beta.

- At present, the outfall of White Oak Dam is considered the point of interface between ORNL and the environment. Should this interface ever be moved upstream of this point to where activity first enters White Oak Creek or White Oak Lake, the activity releases at the new interface point would be higher than those now reported. The existing monitoring system does not allow one to determine how much of an increase there would be as a result of this change, but from the readings at Sample Stations 3 & 4, it can be seen that the total release would be higher than what is released off-site at White Oak Dam.

2. Excessive Land Usage Caused by Present Burial Practices

As noted above, the second undesirable feature of shallow land burial, as practiced at ORNL, is the relatively large amount of land usage. Since this land is contaminated, either directly or indirectly as a result of this practice, it would be rendered useless for other purposes for several hundred years after the site is closed (Rodgers, 1979). Compounding this is the fact that ORNL's geological/hydrological conditions are not well suited to this method of disposal. The ORNL site is composed primarily of four geological units. These are the Conasauga Group, the Knox Group, the Rome Formation and the Chickamauga Group. A detailed study of the characteristics of each of these groups and the potential of areas underlaid by them for shallow land burial has shown that only the Conasauga and Knox Groups have reasonable potential for waste disposal (Allen 1980). The Knox Group being the less desireable for radioactive waste, the referenced study recommended that the Knox Group areas be reserved for sanitary landfill and that the Conasauga shale areas be used for radioactive waste disposal.

The Conasauga Group is composed primarily of shale and limestone formation. This group has relatively high sorptive properties and moderate ion-exchange capacities, resulting in some degree of retardation of the migration of certain radionuclides. However, this benefit is offset somewhat by the fact that fractures are often found in these formations, allowing radionuclides to migrate into the groundwater. This factor, coupled with the relatively shallow depth to the water table (from zero to six meters in many areas of both Melton and Bethel Valleys), places limitations on the type of shallow land burial techniques used, which in turn result in less efficient land usage (i.e. less waste buried per m^2 of surface area). These factors were not fully considered when SWSA-1, 2, 3 and 4 were opened. Some of the waste in these areas was buried very close to the existing ground water level, resulting in the waste being inundated during periods when the water table was above normal. Undoubtedly, conditions such as this are a major cause of the uncontrolled activity releases observed in White Oak Lake.

In operating SWSA-5 and 6, more care has been taken to remain above the water table and to keep surface water runoff out of the trenches while they are being filled. However, since the water table is high in a large portion of both of these disposal areas, larger land areas have had to be used per volume of waste disposed of. In spite of these precautions, a detailed study conducted in 1980 (Allen) has indicated that shallow land burial, as presently being practiced at ORNL, does not meet certain requirements of existing RCRA and EPA guidelines for hazardous waste disposal, as well as those proposed in draft Title 10 CFR 61 for radioactive waste disposal. This report goes on to state that because of ORNL's site specific conditions, all of these regulations would have to be modified or ORNL's burial techniques would have to be substantially upgraded if ORNL were ever required to follow these regulations.

Other studies have reached conclusions similar to those given above. For example, a recent review of all existing low-level waste burial sites by the U.S. Geological Survey (Robertson 1979) concluded "that all sites ... except Oak Ridge, Tennessee, and possibly Maxey Flats, Kentucky, might have acceptable geohydrologic conditions, if the quantity of water entering the filled trenches through the trench caps could be adequately controlled."

As another example, the Safety Analysis Report for SRW disposal activities at ORNL (Binford and Gissel 1975) concludes that "while burial of slightly contaminated waste is undoubtedly the quickest, cheapest and perhaps safest way to remove it from the environment, the procedure is wasteful of land because it utilizes a very large area for the storage of a very small amount of radioactivity."

The negative aspects of shallow land burial, as practiced at ORNL, are compounded by the fact that waste volumes are not reduced to the maximum extent possible before disposal. Chapter 0511 of the DOE Manual states that "technical and administrative efforts shall be directed toward a marked reduction of a) the gross volume of solid waste generated in (DOE) operations and b) the amount of radioactivity in such wastes. Volume reduction technology, such as compaction and incineration, shall be adapted for use with radioactive solid wastes and placed in operation wherever practical." In the past few years, ORNL has taken numerous steps to improve compliance with this policy. These have included: a) emphasis on control of materials entering contamination zones; b) segregation of noncontaminated waste from contaminated waste and locking of the major collection containers (dumpsters) for contaminated waste with assignment of the access key to the dumpsters to the health physics surveyors; c) separation of low-level radioactive waste into a compactible part (with compaction at the burial ground prior to burial) and a noncompactible part; d) a decontamination program; e) better packaging to reduce voids and facilitate handling; f) operation of a landfill for low-hazard contaminated waste, (i.e., waste with no measurable contamination by radiation survey but judged, because of its history, to be radioactively contaminated above "green tag" limits) and finally; g) charging of generators for disposal of currently generated waste.

These efforts in combination with the fact that in recent years the Laboratory has reduced R & D efforts in areas requiring the handling or production of radioactive materials, have been successful in helping to reduce the amount of waste buried since 1977 to 50 percent of the average amount buried in the previous ten years. Nevertheless, at the present rate of generation, SWSA-6 will be filled within ten more years, requiring that a new SWSA be constructed by 1988 to meet the needs of the laboratory after 1990. Given the problems associated with shallow land burial at ORNL, expansion of the present burial grounds without a commensurate effort to further reduce the volume of waste generated does not fully satisfy DOE's stated objective of minimizing "the extent and degree of radioactive contamination of land by (DOE) waste management activities" (Pittman 1973).

Assignment of a priority level to the concerns addressed here is complicated first by the fact that these concerns deal with both existing burial grounds and future burial practices and second by the fact that the concerns are somewhat different in each case. For existing burial trenches, disposal pits, etc., the total amount of activity migrating into ground water that reaches the site boundaries seems to have leveled off at a small amount which does not represent a significant hazard to the general public or the environment. However, because of the unknowns and uncertainties associated with these existing wastes, the potential does exist for more significant interactions between them and the environment in the future. For this reason, this portion of the concerns discussed herein is considered a Priority Level III item for planning purposes. For future waste disposal activities, factors such as more restrictive regulations and increased volumes of waste (due to D&D activities, new pilot plant projects, etc.) could have a significant impact on the requirements for volume reduction and the techniques to be used for disposal of wastes in SWSA-7. The impact these factors will have on the design and economics associated with SWSA-7 could be substantial and for this reason, concerns over future waste disposal activities have been assigned a Priority Level II for planning purposes.

3.1.1.2 Recommended Actions

1. Existing Burial Trenches

- For the existing SWSA's, current programs for investigating the environmental impact of the buried wastes and means of mitigating these effects should be continued. These programs are needed for identifying solutions to ORNL's site specific problems. In addition, the information learned from these R&D programs will be of great value to those involved in the planning of future shallow land burial facilities on both national and regional levels.

  Program planning for these R&D projects is outlined in detail in DOE Field Task Proposal/Agreement Number ONL-WN02 (Task Title "ORNL Site Specific Low Level Waste Studies"). Gilbert/Commonwealth has reviewed this and related documents and is in general agreement with the scope and direction of these projects. However Gilbert/ Commonwealth believes there are two areas in need of further definition and development in these plans. The first of these has to do with need for a more quantitative definition of the improvement objectives for ORNL's site specific conditions. Previously, note was made of the fact that quantitative numbers do not exist for determining whether or not operation at DOE sites are being conducted in an ALARA manner. At present, the amount of activity being released from ORNL's burial sites is already quite low. Therefore, before proceeding with costly, long range projects to further reduce releases, some specific goals should be set in terms of the annual quantity of activity discharged, the rate of progression of land area contamination via migration through the groundwater, and acceptable on-site groundwater contamination levels.

The second area needing improvement has to do with defining the interrelationships between ORNL's R&D efforts and the needs for national and regional efforts to upgrade shallow land burial practices. There is no question that much of the work being done or being proposed by ORNL will be of great use in these generic efforts. However, no where in ORNL's present planning documents is it apparent that formal discussions have been undertaken to clearly define the direction and approach ORNL's R&D efforts should be taking to support these broader based plans in the most efficient and cost effective manner possible. Through discussions with the other agencies and groups involved, these requirements should be formalized and made a part of the planning of ORNL's future R&D efforts in this area.

- A formalized groundwater monitoring program should be established for all of the existing SWSA's, including the abandoned chemical waste disposal sites for liquid intermediate level wastes. Several studies have already been made (Switek, 1980 & 1981) to determine the number and location of monitoring wells required to satisfy the needs of such a program. Gilbert/Commonwealth concurrs with the recommendations of these studies, particularly the need for monitoring groundwater in the area at the head of Racoon Creek. Gilbert/Commonwealth also recommends that monitoring include other areas that would not appear, on the basis of topography alone, to be areas where radionuclide migration via groundwater could occur, but where such migration may occur as a result of either fractures in the shale formations or the creation of channels in the limestone "stringers" that have been found in some shale formations on the site. In particular, the drainage area on the northwest side of White Wing Road adjacent to SWSA-6 should be included, since this area drains into the Clinch River downstream of any monitors on White Oak Creek.

In setting up this program, efforts should be made, where possible, to coordinate the work with that of other agencies (EPA, US Geological Survey, etc.) to avoid unnecessary duplications of effort and other inefficiencies. A cooperative effort on the part of these groups in developing and operating the monitoring program might also permit expansion of the program (number of wells, area covered, sampling frequency, etc.) without additional expenditure on the part of any of the agencies involved.

Formal procedures should be developed for all aspects of the monitoring program. As a minimum these should address the following:

a. Selection of well locations

   i) Criteria for selecting locations
   ii) Approval chain for selected locations

b. Sampling requirements

   i) Frequency
   ii) Sample parameters

c. Reporting requirements

   i) Distribution
   ii) Frequency

d. Interrelationship with disposal operations

i) Establishment of benchmark background water quality levels
ii) Criteria for unacceptable water quality levels
iii) Corrective action requirements/notifications

e. Periodic review/update of monitoring program needs

i) Application to new SWSA's
ii) Adjustments for changes in conditions (increases in migration rates, etc.)

The groundwater monitoring program is an integral part of the long term site surveillance required for any radwaste burial operation. For commercial sites, surveillance programs must be established that will endure for 150 years or more. Programs for DOE sites such as ORNL should be at least as durable. Therefore, the importance of properly documenting the design of the monitoring system and formalizing procedures for use of this system cannot be overemphasized.

o For existing burial grounds, if uncorrectable problems develop in the future, then as a last resort, the ORNL may need to consider exhuming individual trenches on a case-by-case basis. Exhuming and redisposal of these wastes poses potential problems in itself and such an eventual course of action will have to be carefully planned. In preparation for responding to such conditions in a timely manner, preliminary plans should be developed now for exhuming a typical disposal trench. The most likely candidate for such action would be one of the abandoned liquid ILW disposal pits, which together contain more than one million curies of mixed fission products. As a starting point for this task, the exhumation methods developed for a generic commercial shallow land burial facility (Murphy and Holter, 1980) should be applied to ORNL's site specific conditions. This approach would not only reduce the cost of planning such a project for the ORNL site, but would also serve as a valuable check of the validity and completeness of the NRC's generic planning documents for decommissioning shallow land burial facilities.

In order to develop plans for decommissioning an ILW disposal pit, the isotopic content of these pits must first be know. This information would be available as a result of the work outlined in Section 3.2.3 of this appendix. On the basis of this data being available and use of the decommissioning plan outlined in NUREG/CR-0570, site specific planning for ORNL's disposal trenches would require an estimated six months and 2000 engineering manhours to complete.

2. Future Waste Disposal Operations

o At the present rate of waste generation, the storage capacity of SWSA-6 will be entirely used up within ten years. The capacity of this burial facility could be depleted even sooner if large scale decommissioning of surplus facilities and/or startup of any major new plant projects were to occur within the next ten years. On this basis, new burial facilities could be needed within another five years. Therefore, planning, site selection, and environmental monitoring programs for the candidate sites should begin as soon as possible. Specific objectives that this new burial facilitiy should meet are:

a. Adequately handle the anticipated additional volumes of waste generated by future D & D projects and/or future pilot plant projects, assuming no improvements over present segregation, packaging or volume reduction techniques prior to disposal.

b. Compliance with existing RCRA and EPA guidelines for hazardous waste disposal where these apply to ORNL's wastes.

c. Compliance with the intent of NRC requirements for commercial shallow land burial facilities, as proposed in draft Title 10CFR61.

Several studies have already been undertaken to identify the necessary attributes of a burial site and of burial techniques to meet these objectives. After reviewing these studies, G/C concurs with the recommendation by Chancy, et.al. (1980) that the new SWSA should be a hybrid combination of diked (mounded) trenches, unlined trenches, and concrete modules. Design of the new SWSA should begin on this basis. However, upon completion of this design work, the impact of increased volume reduction of wastes should be considered, based on the outcome of the VR study called for under Item 2b below. The disposal facility design should not depend on any new volume reduction capability beyond what is presently available (i.e., compaction of dry compressible wastes). However, the inherent flexibility of the hybrid design would allow future changes to be made (such as the number of concrete modules versus diked trenches, etc.) as new volume reduction capability is added at some future date.

Two alternatives to the hybrid shallow land burial facility were considered during the course of this study. These were engineered storage facilities and offsite disposal. While both of these options have certain advantages over onsite shallow land burial, it was concluded that these are outweighed by their disadvantages as discussed below:

Engineered storage facilities are an extension of the simple concrete bunker arrangement. Their chief advantage is that they completely isolate the stored waste from the environment and are indpendent of site geology/hydrology conditions. However, the cost of such a facility is in the range of \$1200 to \$1500/m^3 of stored waste, whereas a concrete bunker is estimated to cost \$250/m^3 of stored waste (Clancy, 1980). In comparison, the base costs for disposal of ORNL waste by trench burial and hydrofracturing are currently \$268/m_3 and \$264/m^3, respectively. Under recently enacted guidelines, ORNL waste generators can also be assessed radiation penalty fees amounting to as much as 100 times the base cost depending on activity levels and storage/disposal method. By properly segregating wastes into categories for disposal via trench, diked trench or concrete module, the advantages of an engineered storage facility (i.e., minimal land usage and land containination) can be attained to a satisfactory degree without the significant expense associated with engineered storage facilities. Looking at the costs presented above, it is obvious that the use of engineered storage facilities at ORNL on a large scale would only be viable (economically speaking) if additional VR equipment were in place to substantially reduce the volume of waste to be stored. However, placement and operation of VR and repackaging facilities add substantial costs in themselves. A study conducted for ORNL by Bechtel (Stang 1980) has estimated that the construction costs for an incineration and metals reduction facility would be $25 million. Assuming a thirty year life for the facility and that 1300M^3 of waste were handled each (See Table A.1-2), the capital cost of the facility alone would be \$640/M^3 of waste handled. Based on operating experience at Ontario Hydro's Bruce generating station and other data, the operating costs of the incinerator and follow-up solidification system would be approximately \$500/M^3 and \$750/M^3, respectively. While these simplistic cost figures cannot be used to determine the economics of VR for ORNL, they do tend to show that on the basis of cost alone, large scale VR for ORNL's wastes may not be practical. Other, more intangible factors, such as the desire or need to reduce land utilization contamination and ORNL's leadership role in developing and demonstrating new technologies may be necessary to consider in order to justify large scale VR at ORNL.

The second alternative to improve onsite shallow land burial techniques would be to package the waste for transportation to a regional disposal facility that has superior geological/hydrological site conditions. This would eliminate land usage and contamination of the environment around ORNL altogether but would have the following disadvantages:

a. Unless the regional facility was an engineered storage structure or deep geological disposal site, this alternative would only transfer the land utilization and contamination problems from ORNL to another location.

b. The added cost for packaging and transporting the wastes offsite would increase the total disposal costs substantially. For example, shipment of dewatered or dry waste in a liner and shieled cask from a southeastern state to Barnwell, SC costs \$700 to \$1400/m^3 for the disposable liner and transport vehicle. Manpower costs for packaging and inspection before shipment could add as much as \$350 to \$700/m^3 to these costs. In comparison, disposal at Barnwell costs \$125 to \$500/m^3, depending on radiation level and container size. For this example, then, transportation offsite could increase total disposal costs by a factor of five to ten over the cost of onsite disposal.

c. The added risks of dispersion due to fires or transportation accidents and the increases in personnel exposure attendant with the increased amount of handling that would be required would offset the long-term health and safety benefits gained by removing the waste from the site.

d. Political, legal and regulatory obstacles would have to be overcome before this waste could be shipped offsite, especially if the regional site was also being used to dispose of commercial nuclear industry waste. Such a facility would come under the regulation of the NRC and proposed 10 CRF 61, which is now being circulated industry-wide for review and comment. This regulation sets up three basic categories (A,B, & C) of wastes for handling by a shallow land burial facility. The characteristics of these waste categories, the packaging requirements for each and the burial methods for each are summarized in Tables B.3-14 through B.3-17. Of particular interest to ORNL is Table B.3-15, which gives the proposed activity limits for all categories of waste to be accepted for shallow land burial under these new guidelines. Comparing this table with Table A.1-1 for ORNL's SRW, it can be seen that, taking ORNL's SRW as a whole and averaging the activity level, these wastes would be considered Class B or C waste (if the predominant isotope were Sr-90). Comparing this table with the data in Table A.1-13, it can be seen that it would not be possible and a 10 CFR 61 rules to solidify and bury much of ORNL's intermediate level wastes in a commercial shallow land burial facility because of the high activity levels in these wastes.

Considering all the above disadvantages, transportation of ORNL's wastes offsite for storage or disposal does not appear to be viable at this time. However, because future changes in regulatory or economic conditions could alter this conclusion, it is suggested that ORNAL take an active part in any formal discussions concerning creation of a regional storage/disposal facility for the southeastern part of the United States.

For a new SWSA, it is estimated that a minimum of three years would be required to select a site, set up an environmental monitoring program, design the facility, and perform initial site work (grubbing, grading, construction of administration/maintenance facilities, etc.). These initial design and construction costs are estimated to be 2.5 million dollars. Operating costs, which are not included in this figure, would not be substantially different from ORNL's current costs for operation of a shallow land burial facility.

- A comprehensive study should be conducted of all potential means of volume reducing ORNL's various types of liquid and solid radioactive wastes prior to disposal. Where necessary this may also entail small scale testing or demonstration programs. The results of this work would be used to determine what additional VR methods should be instituted now or at some time in the future. Consideration should be given to the full range of VR options, from modest, small scale project such as better segregation of wastes to major capital improvement projects such as installation of an incinerator. A partial listing of VR options which should be addressed is included in Table B.3-13.

Each VR option should be evaluated separately on the basis of at least the following parameters:

a. Effectiveness in reducing overall volume of waste.

b. Operating experience

c. Maintainability

d. Durability

e. Safety (radiation exposure, criticality, process safety, normal/ accident situations, etc.)

f. Potential as a subject for R&D work by ORNL

g. Flexibility for handling future D&D and/or pilot plant wastes

h. Availability (commercially available, conceptual design stage, etc.)

i. Applicability to commercial power plant wastes

j. Economic viability (net savings or increase in capital/operating costs) consider both present economic parameters and future changes in these parameters, such as DOE's directive to begin charging user's of ORNL's shallow land burial facility at rates which are comparable to those of commercial burial facilities.

k. Impact on various disposal methods (current and future methods)

The results of this study should be presented in a document format that will allow for periodic updating as necessitated by changes in technological, economic, or regulatory conditions. The resulting report would be used as a basic source document for making waste management planning decisions; and as such, it should be reviewed and updated periodically to remain relevant and useful to ORNL's needs.

In order to conduct this VR study effectively, complete information must first be gathered concerning the wastes produced by all present and potential future liquid/solid radwaste generators. For liquid wastes, this information would be available as a result of the work outlined in Appendix B.3.5.3. Similar background information should be gathered for all solid radwaste generators (a great deal of this information is already available in the SWIMS reports). Once all of this information has been collected, it is estimated that the initial VR study would require 3000 manhours and six months to complete.

- Proceed with planning of a joint venture for installation of a hazardous waste/radioactive waste incinerator for shared use by all UCC-ND sites. Conceptual plans for this incinerator have been completed and the project is now on hold for the next budget cycle. At present, the conceptual design calls for this facility to handle only U-235 contaminated waste. The potential for expanding this capability to permit incineration of other types of low-level radioactive waste should be explored during the detailed design phase of this project.

3.2 LIQUID RADIOACTIVE WASTE (LRW) MANAGEMENT

3.2.1 Liquid LLW Collection

3.2.1.1 Discussion

The liquid LLW collection subsystem for ORNL is shown schematically in Figures 3.2-3 and 3.2-4. The available data for this subsystem are incomplete and do not accurately reflect conditions as they currently exist. The radwaste system atlas drawings idnicate the general piping configuration for the subsystem as of December, 1970, but do not reflect additions or modifications made since that time. The relative age of the system piping and hydraulic information, such as pipe invert and pond elevations, are not recorded on these drawings. This general lack of complete and accurate system information is an easily retrievable form has prevented a comprehensive evaluation of the adequacy of the collection system.

Another major source of extraneous system flow is attributable to in-leakage into the collection system under Building 3047 (Burch, 1972). In addition to these two identified sources of extraneous water, the relative age of the system indicates a potential for other unidentified sources of in-leakage into the system. There are numerous mechanisms by which extraneous flow can enter a collection system. The primary mechanism in older vitrified clay pipe systems is by faulty joints in pipe sections. In conventional collection systems this form of in-leakage can account for the majority of the extraneous system flows. Pipe failures due to settlement or loading, inflow through manhole covers and in-leakage through manhole walls are common sources of the remaining extraneous flows.

There is insufficient data available to accurately assess the condition of the collection system piping, all of which is buried underground. However, there are a number of things that point toward the conclusion that this system is leaking badly. Much of the piping is vitrified clay pipe installed 30 or more years ago. A note alongside one section of eight-inch pipe shown on the system atlas drawings states that this pipe "presently acts as a French drain, though not by intent." During heavy rainfall periods, the LLW system operators report that input volumes to the system are extremely high, approaching the system's processing capability limit. This again points to the likelihood of major leakage points in the collection system. Conditions such as those described above would cause in-flow of unwanted ground water after heavy rains or when the water table is high. Not only is this situation undesireable from the standpoint of increasing operating costs, but it also decreases the processing system's efficiency for removal of radionuclides and increases the potential for releasing excessive waste volumes directly to the environment via existing automatic overflow diverters which bypass the process system altogether during peak load periods, sending the excess flow directly to White Oak Creek or the sanitary waste system. During dry periods when the water table is low, contaminated waste water could leak out of these faulty pipe sections, creating a situation that does not conform to monitoring requirements and ALARA criteria for releases of radionuclides to the environment.

The LLW collection system has insufficient capability for detecting system in-leakage or out-leakage or for pinpointing the source of leakage. There is no means for isolating and testing individual runs of piping. As shown in Figure A.2-3, not all of the manholes in the system have equipment for monitoring flow rates; and in most cases, there are numerous buildings and large amounts of piping upstream of each of these monitoring points. Currently, the only way of detecting a leak is to shut off the water supply to the section of the complex suspected to contain a leak and to observe any change in total input to the LLW system. Besides the obvious inconvenience this causes (it is usually done on a weekend to minimize the impact on other activities), it does not pinpoint the source of leakage, since there are hundreds of feet of buried piping between the monitor station and the known water sources (i.e., buildings with domestic water supply lines).

Evaluation of available data indicates the existence of numerous hydraulic design limitations in the collection system. The severity of these hydraulic constraints cannot be fully evaluated due to the lack of accurate elevation data and peak flow data for the collection system. A major hydraulic constraint exists in the collection system servicing Buildings 2000, 2001 and 3017. The LLW from these buildings is transported through 25.4 cm vitrified pipe to Manhole 93. The effluent line from Manhole 93 is a 20.3 cm vitrified pipe. This configuration is subject to potential line blockage and flow restriction. At present, none of the work being done in these buildings involves the use of radionuclides that could enter the drainage system, so the drains from these buildings have been diverted to the storm drains. Should the need ever arise to redirect these drains to the LLW system, the problems with the present piping arrangement could cause a flow blockage that would result in radioactive waste overflowing to the storm sewers. Additional flow constraints exist in areas where the gravity lines change direction without the use of manholes. This configuration is subject to solids accumulation and should be avoided when feasible. Blockages occurring in areas where this has been done would require extensive efforts to remove.

The remaining area of concern in the LLW collection system is the use of overflow bypasses to the storm sewer collection system should current State and EPA regulations governing treatment/collection system bypasses become applicable to the ORNL site. They might require elimination of the existing system bypasses and overflows because their potential use during peak loading periods could result in a situation that would not be ALARA. Elimination of these safety valve features would be expected to have a major detrimental effect on performance of the LLW processing system during these peak periods.

Due to the very low activity levels normally present in the LLW input streams ($<10^{-5}$ μCi/cc), the uncontrolled release of radionuclides into the groundwater via this pathway is not considered to be a significant safety hazard. Since the processing costs for the LLW system are also very low, (\$1.30/1,000 liters), economic concerns over this situation may also be insignificant at present. On this basis then, this area is considered a Priority Level III item at this time. However, as discussed below, these concerns could attain a higher priority level in the future under different operating and/or regulatory conditions.

3.2.1.2 Recommended Actions

1. In order to fully evaluate the conditions of the piping for the existing collection subsystem, complete and accurate information is required. The existing collection system should be verified by spot field checking against the available drawings; and all modifications, invert elevations, pipe material, manhole elevations, etc. should be annotated on a single set of system drawings. These drawings should be updated upon completion of any additions or modifications to the system and reflect true as-built conditions. This basic information is essential for full evaluation of the LLW system and efficient operations and maintenance activities. This task could take three to six months to complete and require up to 1,000 manhours of engineering time.

2. Upon assimilation of accurate and complete system data, a water balance for the collection system should be performed to identify problem areas and to verify previously reported conditions. As part of an overall system water balance, additional flow measurement devices should be installed to quantify the waste flows generated from each building and to obtain system flows during wet and dry weather periods. The flow measurement devices recommended are portable non-electric V-notch totalizing units as shown in Figure A.3-1. These units are available for standard pipe sizes ranging from 15.25 to 38 cm diameters. The estimated (April 1981) budget cost for purchase of individual units is approximately $2,000 per unit. These units are also available on a rental basis from the manufacturer. Additional weir and probe assemblies are available without the bubbler and totalizer system for prices ranging from $329 for a 15.25 cm weir to $427 for a 38 cm weir (April 1981 unit prices). Individual weir and probe units may be left in place to routinely check flows in critical areas of the system.

   In order to assimilate accurate system flow data for wet and dry weather conditions, flow data is required for each area in the system. These data can be collected in one of two general ways. The first method is to place sufficient flow measuring devices within the system to simultaneously collect data from all areas. This approach would possibly require up to 30 individual flow recording units. A second, and more cost effective, method would be to monitor one section of piping at a time and then correlate the sum total of this data to the total system flow, as recorded at the inlet to the process waste basin. This approach would require a minimal number of flow monitoring units, ranging from a low of two units up to as many as six, depending on the size and complexity of the individual section being monitored. For either method, precise requirements for locating the monitors should be determined from data obtained from verified, as-built design drawings, supplemented by field investigations where necessary.

   The time span required to assimilate the necessary flow data will vary with the method of data aquisition used and climatic conditions prevailing at the time of the program start. Under normal conditions, this time span could be expected to range from six to nine months, requiring 500 to 1,000 manhours to complete.

3. Upon completion of the overall system water balance, a number of alternative system correction methods should be developed and evaluated. Possible collection system alternatives include the following:

- o Replacement of existing manhole covers with water tight units.
- o Grouting of exterior portions of manhole walls with waste compatible grouts such as 3M-OAKUM-FMBACO Mix.
- o Replacement of manholes with precast water tight units.
- o Collection line replacement.
- o Slip lining existing collection system (15.25 cm and larger pipe) with extruded liner such as Phillips Petroleum Drisco pipe liner.
- o Grouting individual pipe joints with waste compatible grout such as 3M Foam.
- o In situ lining of existing collection system (15.25 cm and larger pipe) with membrane liner.

Each of these alternatives should be evaluated on the basis of the relative effectiveness in stopping inleakage/outleakage, service life, total costs, constructability, and disruptive impact on ORNL operations during installation. In making this evaluation, the impact of proposed D&D activities on overall system flows should be used as input in addition to the data gained from the water balance study.

The precise level of collection system corrections required is a function of treatment costs, disposal costs and ALARA constraints. A major factor to consider in evaluating the cost versus benefits of any of these improvement alternatives is the potential these corrective actions have for eliminating the need to process LLW on a routine basis prior to discharge. Inspection of Table A.1-9 indicates that since 1977, 90 to 96 percent of the radionuclides coming into the LLW system originate from two sources - inleakage of groundwater between MH 112 and MH 114 and the tank farm drainage. The first of these could be eliminated if the section of drain piping in question were replaced or repaired, and the second will be eliminated once the tank farms are decommissioned. Thus, if these tasks were accomplished, a reduction of 90 to 95 percent in activity releases would be realized without any processing at all. In comparison, data from a recent evaluation of the LLW treatment plant (Chilton 1980) indicated that activity reductions of 93 to 98 percent were achieved for sample runs through the SP-IX process. This suggests that once these two large contributors of activity have been eliminated, all wastes collected in Process Basin 3524 could normally be bypassed directly to White Oak Creek without any processing, as is now normally done for wastes collected in Basins 3539 and 3540. Based on an operating cost of $1.30/1,000 liter of raw waste for the LLW treatment plant, this would result in an annual savings of over $200,000 in operating costs. Bypassing of the LLW treatment plant under these conditions also appears to be acceptable from an ALARA standpoint, since, to process the LLW that remains would mean an additional reduction in activity releases of only five to 10 percent below a value that already is well below MPC levels.

Another significant cost factor to consider in determining the cost benefits of these alternatives is the cost that would be incurred if it is ever made a requirement that sludge from the LLW processing plant be solidified rather than disposed of in open pits as is now the case. This would add significantly to the cost of operating the LLW system and would be an additional justification for making any repairs to the collection system that would substantially reduce the volume of waste inputs to the system.

Weighted against these possible operating cost savings are the capital costs associated with each corrective action alternative. Estimated costs for each of the alternatives are summarized below:

Alternative Correction System 1 - This correction method includes the replacement of manhole lids with water tight covers, grouting of exterior surface of the manholes, televised observation and cleaning of the line segment in combination with pressure testing all joints in pipe and grouting 30 percent of the pipe joints. The grout used for the pipe segment is 3M Foam grout. The pipe joints are water pressure tested under one-pound pressure. Those joints that fail are grouted and retested. If the joint fails again, the process is repeated until it passes.

The grouting of the exterior walls of the manholes is accomplished by excavating around the manhole, light cleaning of the walls and an application of a mixture of 3M and Oakum mix 7.6 to 15.25 cm in thickness. This initial coating is then covered with an application of waterproofing grout. The completed unit is backfilled after curing. Total cost for this alternative averages out to $19/meters for pipe ranging in diameter from 20.3 cm inches to 38 cm.

<u>Alternative Correction System 2</u> - This correction method includes replacement of manhole covers and grouting of the exterior manhole walls as in Alternative Correction System 1, but in lieu of grouting the line segment, a slip liner is to be installed.

Prior to slip lining the line segment, the collection line is television inspected and cleaned. A pit of sufficient length is excavated downstream of the lower manhole and an access hole is made into the system for insertion of the liner. Pulling cables are installed between the access point on the upper manhole and the liner is attached to the puller system. Sufficient lengths of extruded liner (SDR 32.5) are field joined prior to the start of the pulling operation. The liner is pulled through the line and bonded to the existing pipe at the manholes by filling the annular space with a bonding material. Upon completion of the line installation, the access pit is backfilled. For this alternative, the total cost ranges from $80/m for 20.3 cm diameter pipe to $116/m for 38 cm diameter pipe.

<u>Alternative Correction System 3</u> - This correction method includes replacement of manhole covers and grouting of the exterior manhole walls as in Alternative Correction Systems 1 and 2, but in lieu of using an extruded liner, a membrane liner is to be installed.

Prior to installation of the membrane liner the collection line is television inspected and cleaned. A custom fabricated resin coated membrane liner is prepared. One end of this liner has been sealed to form a bag arrangement. The liner is installed in the pipe by floating the liner down the pipe with water as shown in Figure B.3-2. Once the liner has been fully extended in the pipe, the bag is filled with water to place the membrane against the existing pipe wall. To bond the membrane to the pipe wall, the water is heated to a predetermined temperature and maintained for a set period to allow the resin coating to form a bond between the membrane and the pipe wall. The temperature in the segment is monitored to ensure a good bond. Upon completion of the bonding operation, the sealed end of the membrane is cut off and the water drained out. The ends of the liner are bonded to the existing pipe ends with the use of resins and grout as required. For this alternative, the total cost ranges from $174/m for 20.3 cm diameter pipe to $220/m for 38 cm diameter pipe.

Alternative Correction System 4 - This correction method involves the total replacement of the existing line segment and manholes. Due to the large amounts of underground piping already existing in the ORNL site and the existance of curbs and pavement, the costs for total system replacement is considerably higher than would normally be encountered in the installation of a new system. Total cost for this alternative ranges from $103/m for 20.3 cm diameter pipe to $148/m for 38 cm pipe.

For each of these corrective alternatives, the estimated cost for correcting the entire LLW system is shown in Table A.3-1. These costs are for comparison purposes only and do not reflect the exact cost for the ORNL site. The precise method or combination of correction methods most cost effective for the ORNL site may vary from those alternatives considered. The alternatives presented are typical methods utilized to correct extraneous flow conditions in existing collection systems. Each alternative method has its own individual benefits and limitations. The use of grouting on existing collection system line segments is only feasible for lines greater than 10.2 cm in diameter, with maximum horizontal deflections of less than 10 degrees. Grouting can not be used to repair crushed pipe or joints which are severely offset.

The use of extruded slip lining for repairing of collection systems is restricted similarly to grouting. In addition to horizontal and vertical deflection limits, slip lining requires large areas with relatively free access for installation of liners.

A membrane liner system can be used in areas where horizontal and vertical offsets preclude the use of the methods described previously. The installation of a membrane liner system requires substantial head-room clearances at grade level for the installation equipment.

Direct replacement of line segments is restricted to areas where sufficient hydraulic gradients exists to allow rerouting of the collection system. Line replacement is further restricted by existing underground utilities at a particular location. Upon completion of a new replacement section, tie backs to the original system are required to intercept existing building drains.

Approximately two months and 500 manhours would be required to complete an evaluation of alternate correction measures. The time frame for implementing the various correction alternatives ranges from six to eight months for grouting and up to 24 months if the system is replaced. Before any correction alternative, or combination of alternatives, can be chosen, accurate system design data and an accurate system water balance must first be obtained, as recommended in Items 1 and 2 above.

3.2.2 Liquid LLW-Processing

3.2.2.1 Discussion

Process Waste Basin 3524 and Process Waste Ponds 3539 and 3540 are used for intermediate hold-up, collection and mixing purposes prior to sending the collected wastes to Building 3518 for processing or directly to White Oak Creek for discharge. As presently designed and operated, these ponds are not in full compliance with ALARA criteria because they are not fully isolated from the environment, thereby allowing unnecessary release of contamination to uncontrolled areas by various means. All of the ponds are uncovered, allowing insects, birds and other animals to pick up contamination and carry it elsewhere. Contamination left behind on the banks of the basins as a result of seasonal changes in water level can also be carried away by air currents. For the basins that are unlined, radionuclides can also be released into the environment by migration into the groundwater.

Because the ponds are not covered, precipitation falling on them will mix with the waste water to be processed. This increases the burden on the LLW processing equipment, thereby increasing operating costs. During drought periods, evaporation from the ponds would lessen the burden on the processing system, but would cause additional airborne contamination due to uptake of radionuclides in the water vapor.

Process Waste Basin 3524 is an unlined reservoir having a capacity of approximately one million gallons. This basin was constructed by excavation of native materials and has a non-uniform water depth. In certain areas, excavation was incomplete because of the presence of rock, as is evident from the outcropping of rock visible in the western end of the basin. The potential for migration of radionuclides into the groundwater from this unlined basin is high. Furthermore, based on an average annual precipitation of 150 cm, the additional amount of water that must be processed because this basin is uncovered is four million gallons, resulting in an estimated additional operating cost of $25,000 per year for the LLW system. This additional cost could be substantially higher if future regulations mandate solidification of the LLW processing system sludges prior to disposal.

Settling Basin 3513 is an open, unlined basin constructed in the same manner as Process Waste Basin 3524. It contains substantial quantities of both TRU and non-TRU wastes, thereby presenting a potential for significant contamination of the environment. Since this pond is no longer in use and is scheduled to be decontaminated and decommissioned once a number of environmental surveillance and test programs are completed, further discussion of this basin is not warranted here.

Process Waste Ponds 3539 and 3540 are open basins with engineered, compacted clay linings that are approximately two feet thick and that serve as impervious barriers between the collected waste water and the ground water. The water collected in these basins is usually very low in activity and consequently, it is normally not processed before being discharged to White Oak Creek. Under these conditions, it is not expected that these ponds would normally be a problem from either a radiological standpoint or processing capability standpoint. However, no data was available on the radiological content of sludges in the bottom of these basins, the condition of the basin linings, or the potential for off-standard, higher activity waste inputs to these basins. A final assessment of these ponds cannot be made until this data is available.

Based on available data, the concerns identified for these process basins do not appear to be serious enough to require correction at the present time. However, there is insufficient data available to rule out the possibility that some action may be necessary in the future. Because of the potential for stricter future regulations regarding open radwaste processing systems such as this, and because improvements to the system have the potential for lessening the economic impact tighter environmental regulations may impose on the operation, this item has been assigned to Priority Level III.

3.2.2.2 Recommended Actions

1. More detailed information must be gathered on the radiological and design aspects of these ponds. Complete data should be obtained on pond dimensions, bottom elevations, side wall elevations and normal water elevations. In addition, complete analysis of the contents of Pond 3524 is required to evaluate alternatives available. The analysis should include both radiological and chemical analysis with the data compared to groundwater samples obtained from the abandoned eight-inch vitified clay pipe line west of the ponds. This groundwater sample can be obtained from the abandoned weir south of Pond 3524. If comparative analysis of the contents of these ponds and groundwater does not indicate leaching, it is recommended that shallow test wells be constructed in areas adjacent to the ponds for further verification. Groundwater samples obtained from such shallow wells should be sufficient to indicate the ponds integrity.

An environmental monitoring program should also be set up to gather data necessary to determine the potential amount of contamination that could become airborne or carried away by animal life.

It is estimated that the data acquisition and monitoring programs would take 3 and 12 months respectively to complete and involve 500 and 2000 manhours of effort, respectively.

2. Using the data collected above, a detailed assessment should be made of the environmental impact of the release of radionuclides from these ponds to the environment via the various pathways discussed earlier. The cost and effectiveness of alternative improvement plans must be included so that a cost/benefit analysis can be performed to determine whether or not near-term or long-term improvement projects are justified.

There are two possible alternatives available for Pond 3524 that will meet with the intent of ALARA and reduce the potential for groundwater contamination. One is to line and cover the existing basin and the other is to abandon the basin in favor of closed tanks. The first alternative would require extensive amounts of earthwork and decontamination of the existing pond. It is assumed that the use of a liner system would be necessary due to the method of construction employed for the original pond. The type of liner system can be either a 36 mm CPE liner or a clay liner similar to that utilized for Ponds 3539 and 3540. A third liner system is available that utilizes the native soil and blends them with a clay type binder such as Volclay SLS-100. This soil additive is mixed on a proportionate basis dependent upon the analysis of the native soils. For this particular application it is estimated that approximately four pounds of SLS-100 will be required per square foot of basin area to obtain a permeability of 1×10^{-7} centimeters per second. Side slope protection is required for slopes exceeding 0.92 m horizontal to 0.31 m vertical. The soil additive is mixed with the native soil and compacted with vibratory rollers to form a low permeability system.

Relative costs for installation of the various liner systems cannot be adequately addressed without specific data on the existing pond. The activity and chemical composition of the contents could preclude the use of a particular liner system. For information purposes, the current material cost for Volclay SLS-100 is $253 per metric ton (April 1981 cost) and a 36 mm CPE liner currently costs approximately $9.50/m^2. These costs do not include the expense of basin preparation or related work, i.e., they are material costs only. To replace Pond 3524 with an equal volume system would require a pond with bottom dimensions of 38m by 77m and a top dimension of 46m by 84m. These dimensions are based on using a ratio of two-meter horizontally to one-meter vertical side slope, a normal water depth of 1.2m, and 0.6m of free board. The surface area requiring lining is approximately 3930 m^2.

Selection of a suitable liner system must also consider future requirements for solids removal from the pond. A requirement for solids removal will restrict the installation method employed and could possibly preclude a particular liner system's use entirely.

If Pond 3524 is to be lined, it is recommended that the pond also be covered. The cover system can be either a fixed cover, floating cover, or air-inflated system. Due to the high initial cost of fixed roof systems, a fixed cover would not prove cost effective.

The use of a floating cover system constructed of 36 mm reinforced CPE would cost approximately $23.65/m^2 without pond preparation. The impact on the system hydraulics due to the weight of the cover combined with rain or snow loads should be fully evaluated prior to selection of a floating cover system.

Should the system hydraulics restrict the use of a floating cover system, an air-inflated cover system could be utilized. An air-inflated cover is essentially a tent structure held in suspension above the pond by the constant introduction of air. The inflation system consists of a blower assembly and a bleed air flap valve which operate to maintain a uniform internal pressure of approximately 1.65 mm water under all ranges of water level fluctuations. The floating cover system will require modification of the normal operation of a free air discharge to incorporate an air monitoring and cleanup system. Consideration should be given to interconnecting the floating cover discharge air to the existing off gas system at ORNL. Utilization of the existing off gas system, if feasible, would reduce the cost of a floating cover system by eliminating the need for an additional air filtration system. The approximate cost of an air-inflated cover system is $28/m^2$, exclusive of pond preparation and off gas system.

The liner system currently installed in Ponds 3539 and 3540 consists of an essentially impervious clay liner. To monitor the integrity of the pond system, it is recommended that shallow monitor wells be constructed adjacent to the ponds to verify the system integrity.

Depending on the outcome of the survey recommended in item 1 above, Ponds 3539 and 3540 may require covers to fully meet the intent of ALARA. The cover system options for these ponds are identical to the alternatives available for Pond 3524.

The use of closed tanks was listed above as an alternative to lining and covering the existing basins. It is recommended that the use of the decontaminated and decommissioned gunite tanks be investigated as an alternative for this purpose. A study should be undertaken to evaluate the economic and engineering feasibility of lining the gunite tanks and developing a pumped storage system for LLW to eliminate the use of the current pond system altogether. Once the gunite tanks have been decontaminated, they can be lined with a rubber or plastic coating for leakage control at an estimated cost of $11.80/m^2$.

Evaluation of the various alternatives after collection of all data would take approximately two months and 500 manhours to complete. Schedule durations and approximate cost estimates for each of the various alternatives are presented in Table B.3-2. These figures are very preliminary, pending the results of the data acquisition and monitoring program recommended in Item 1.

3.2.3 Liquid LLW Sludge Disposal

3.2.3.1 Discussion

Since 1976, liquid LLW collected at ORNL has been purified by means of a scavenging-precipitation-ion exchange (SPIX) process. Before that, this waste stream was treated by a lime-soda-clay process. Both processes produce a concentrated sludge that has been routinely disposed of by pumping as a dilute (two to four percent by weight) water slurry into open settling ponds. The sludge from the older process normally contained about 60 percent of the Sr-90 in the raw LLW feed and was pumped to disposal ponds that were both open and unlined. The sludge from the precipitator-clarifier portion of the new process normally contains 50 to 70 percent of the total radioactivity in the raw LLW feed and is disposed of in a lined settling basin in Melton Valley.

Roughly five to ten curies of various radioisotopes (primarily Sr-90 and Cs-137) are disposed of in these pits each year. Other basins used in the past for disposal of wastes from various R&D programs (Settling Basin 3513 for example) have received much higher quantities of activity. If these operations were regulated by the NRC, they would not be considered an ALARA practice because of the potential for uncontrolled and unmonitored releases to the environment by various means similar to those discussed in Appendix B.3.2.2. This practice would also not meet the one percent free water limit now in effect at all commercial shallow land burial facilities and as set forth in draft Title 10 CFR 61. Furthermore, these practices do not meet DOE's own standards set forth in Chapter 0511 of the DOE Manual, which states in part that "as soon as technically and economically practical, the use of natural-soil columns (such as cribs, seepage ponds, and similar facilities) ... shall be replaced with other treatment systems." Based on these factors, a Priority Level I has been assigned to this item.

3.2.3.2 Recommended Actions

1. The use of open sludge disposal pits should be discontinued. (During the drafting of this report ORNL completed and demonstrated a waste process that produces no sludge and thus eliminates this problem. The lined basin currently in use will soon be filled and ORNL has been given permission by DOE to continue this practice until a second new basin is filled. This new basin has the capacity to handle the volume of sludge expected to be generated over the next five years. Therefore, within this five-year period, ORNL should take whatever steps are necessary to eliminate production of this sludge or dispose of it in a more acceptable manner.

   The radioisotope inventory for each abandoned settling pond, chemical waste pit, crib or other similar facility should be determined by sample analysis or inspection of operating records. For those facilities that are suspected to be causing trouble, the groundwater around the perimeter of the facility should be sampled to determine if any significant leaching is occurring. For those facilities that are found to be leaching significant quantities of activity or that contain large amounts of activity (such as Settling Basin 3513) the contents should be removed and either packaged for storage or disposal in SWSA No. 6 or disposed of in the hydrofracture facility (where compatible with this process and justified by activity level). Those ponds or cribs that have been filled and abandoned, but that do not contain significant quantities of activity or that do not pose a serious threat of groundwater contamination (such as the lined basin now in use for LLW sludge disposal), should be capped with bentonite clay or other suitable impervious material to divert rainwater and surface runoff away from the facility. Groundwater monitoring should continue on a less frequent basis to determine if further action may one day be required.

   Inventorying of the isotopic content of each existing settling pond or pit and monitoring of the groundwater around each pond is estimated to be a three- to six-month project requiring up to 2000 manhours of effort. The degree and amount of follow-up work required to decommission each pond or pit will be dependent on the outcome of this survey. Assuming disposal of the basin sludge in the hydrofracture facility, complete removal of the contents of a pond such as 3513 would take approximately three months and cost $500,000 to $750,000. Covering a pond this size with material such as bentonite would cost approximately $35,000 and require a month to complete.

2. An evaluation should be conducted of alternative means of handling LLW system sludges after disposal in open pits is discontinued in approximately five years. The options that should be considered are:

   a. Hydrofracture

   b. Package dewatered sludge in containers and bury in an improved shallow land burial facility or store above ground

   c. Solidify in above-ground facility and bury in an improved shallow land burial facility or store above ground

   d. Eliminate portion of LLW process flow sheet that produces sludge.

The sludge from the LLW processing plant is very low in activity, averaging less than five percent of the limit set by DOT for qualifying as low specific activity (LSA) material, for which DOT has specified minimal packaging requirements. The concentration of Sr-90 in this waste is less than 2 μCi/gm, for which the NRC has proposed (Rodgers 1979) that there be no administrative control after disposal. Based on these criteria, any of the options listed above would be more than adequate from a safety standpoint. Therefore, final selection should be based primarily on an economic comparison. The following discussion is not meant to be detailed enough to serve this purpose. It should only be used as a preliminary guide to ranking the alternatives.

Approximately 20 m^3 of sludge is produced by the LLW processing system each year. This is diluted to 300 m^3 (two to four percent by weight) for transfer to the waste pond. For the options listed above, it is recommended that the sludge first be dewatered using a device such as a filter press or traveling belt filter. The dewatering unit should be installed adjacent to where the sludge is to be solidified and in an enclosed concrete block structure. Minimal shielding would be required. Installed cost, including the structure, is estimated to be $100,000. Estimated procurement, construction and installation time is estimated to be 12 to 18 months.

For Option 2-a, it is assumed that cement solidification can handle a maximum solids concentration of 44 percent by weight. Based on this assumption, the solidified volume would be approximately 40 m^3 per year and the yearly cost to operate the hydrofracture facility would be approximately $7,500. Without volume reduction, the cost would be $75,000 per year and an excessive amount of the available shale formation would be used.

Option 2-b (disposal or storage in an unsolidified form) is considered viable because of the very low activity concentration of the LLW sludge. However, in keeping with current criteria for commercial shallow land burial practices, there should be no free water associated with the waste. Therefore, the sludge should first be dewatered using the type of equipment described above. For disposal in an improved shallow land burial facility, thin gauge carbon steel liners are assumed for packaging the waste. At a liner cost of $97 per cubic meter and burial cost of $96 per cubic meter, the total yearly cost for this option would be approximately $3,000. For above-ground storage, thin-walled wire mesh reinforced concrete containers with thin gauge galvanized steel liners are assumed. At an estimated unit cost of $283 per cubic meter, this variation of Option 2-b would cost approximately $4,500 per year.

Above-ground solidification (Option 2-c) could be accomplished by modifying the hydrofracture facility now under construction or by purchasing a mobile vinyl ester resin solidification system. Capital costs for these are given in Appendix B 3.2.7. Because of the superior quality of the vinyl ester resin product, it is assumed that galvanized steel liners would not be required for storage above ground in concrete containers. It is also assumed that the sludge is totally dewatered before solidification in the resin. Encapsulation in vinyl ester resin would result in a yearly volume of packaged waste of 20 m^3. The cost for polymer solidification/shallow land burial is then estimated to be $15,000 per year. The cost for polymer solidification/above-ground storage is approximately $14,000 per year. Cement solidification using the modified hydrofracture facility and coupled with shallow land burial would cost approximately $13,000. If the cement/waste product were stored above ground in concrete containers with galvanized steel liners, the yearly cost would be about $16,000.

Option 2-d would be to eliminate the production of LLW process sludge. There are two possible ways of doing this. One would be to combine the LLW and ILW wastes and process via the ILW evaporator as discussed in Appendix B 3.2.7. This approach would only be possible if the water balance study recommended in Appendix B 3.2.7 showed that a significant reduction in the total amount of LLW could be achieved by repairing or replacing the LLW collection system. The other method would be to modify the process flow sheet for the SPIX system to eliminate the clarifier step that produces the LLW sludge. However, this would increase the burden on the ion exchange columns, resulting in at least a fourfold increase in the number of regeneration cycles for the ion exchangers (based on preliminary investigation by ORNL). This in turn would result in significant operating cost increases for regenerant chemicals and for disposal of regenerant solutions via the ILW system. Additional pre-filtration would also be necessary to protect the beds from plugging with solids. Furthermore, the exact cause of the occasional reductions in performance of the LLW processing system (Chilton 1980) should be identified before making any system changes that may inadvertently add to this problem.

A summary of the costs for the various processing alternatives is presented in Table B.3-3. Options 2a, 2b and 2c appear to be economically competitive based on these very preliminary cost figures. Further information is needed before any conclusions can be reached regarding Option 2d. While refraining from selecting an option until completion of a more detailed evaluation, the most promising alternative at this point appears to be the mobile vinyl ester resin system coupled with above-ground storage. Yearly operating costs for this method, though not the lowest, are still competitive. But beyond this, there are a number of very important advantages to this approach. These are:

a. The capability the mobile unit also has to solidify wastes from the ILW system, future VR systems, and future D&D projects without the expense, hazards and other disadvantages associated with pumping these wastes from the varied and widespread generators to a central point for encapsulation.

b. The superior product characteristic attained by use of the vinyl ester resin.

c. The relative insensitivity of this solidification agent to a wide range of chemical/physical characteristics and activity levels in the wastes.

As noted earlier, a detailed evaluation of these, and any other possible alternatives, is required. This evaluation and development of a preliminary design for the best-evaluated alternative would take approximately six months and 2,000 manhours of engineering time.

3.2.4 Liquid LLW - Contaminated Oil Disposal

3.2.4.1 Discussion

Small amounts of contaminated oil are collected each year and stored in a 18,200 liter tank. Approximately 6,800 liters have been collected to date, containing less than one μCi/cc of activity. This method of storage is acceptable on an interim basis, but should not be considered permanent because of the potential for a fire which could cause an uncontrolled airborne release of radioactivity. In keeping with commercial shallow land burial practices, waste containing more than one percent oil should not be buried. At present, then, there is no means available for disposal of this oil.

At present, the amount of oil being stored and the associated activity do not represent a significant safety hazard. However, as more oil is collected, the hazard associated with this practice will increase proportionately. On this basis, this item has been classified as a Priority Level II concern.

3.2.4.2 Recommended Actions

1. The present plan is to store the collected oil until it can be mixed with waste feed to the new hydrofracture facility. This is acceptable because the resultant concentration of oil will be too low to cause any problems in setting of the grout/mixture after injection into the underground shale formation. It also appears that there is sufficient storage capacity available to store any additional contaminated oil between now and when the hydrofracture facility is expected to go on line.

2. An alternate disposal plan should be available in the event that the hydrofracture facility should encounter problems that would prevent or delay its operation for any reason. One acceptable alternative would be to burn the oil in an incinerator. The possibility should be explored to transportimg the oil to the site of a centralized incinerator used to burn PCB contaminated oil from all four UCC-ND sites. Such a centralized facility has been proposed (Little 1980). Minor, if any, modifications would be required to permit combustion of radioactive contaminated oil in this proposed incinerator, and the safety features built into such an incinerator for handling highly toxic wastes such as PCB's should be adequate to ensure safe disposal of ORNL's radioactively contaminated oil, assuming no significant increase in the activity level of future waste oil.

3.2.5 Liquid LLW-Discharge/Recycle

3.2.5.1 Discussion

The liquid LLW system is a once-through type operation, i.e., all collected wastes are processed and/or monitored and then discharged. As indicated by Table A.1-9, the system collects an average of 2.3×10^5 m^3 of water per year, containing an average of 14.7 curies of total activity. Analysis of this water (Chilton, 1980) indicates that of this total activity input to the system, only

0.5 to 1.0 curie remains in the effluent discharged to White Oak Creek. There are no quantitative guidelines at present to indicate whether or not this amount of activity release is ALARA or not. If ORNL were a power reactor site under NRC jurisdiction, a five curie/year limit would be imposed; and since as noted in Appendix B.3.1.2, the total site discharge has at times exceeded 5 curies, individual contributors to the total then would have to be considered in terms of this site total.

ORNL's LLW system discharges are currently well within limits set by DOE. The ALARA criterion cited above is an NRC guideline. Some modified version of this guideline may one day apply to ORNL, but it is not a requirement at present. For these reasons, this item has been given a Priority Level III rating at this time.

3.2.5.2 Recommended Actions

1. Conduct a study to identify all reuse applications for LLW system process water effluent. This study should address such factors as:

   - Required water quality versus quality expected in LLW process system effluent. Impact of using lesser quality water if effluent does not meet these requirements.

   - Radiological impact. Potential for activity buildup in system. Modifications required to prevent cross-contamination of potable water systems.

   - Required amount of water for reuse application. Frequency of need. Flow rate, pressure and duration per occurrence. Need for reservoir storage to meet usage demand.

   - System modifications required to be able to make use of recycled water (new tanks, pumps, heat exchangers, distribution, piping, etc.).

   Using the data gathered above, a cost-versus-benefit analysis can then be performed to determine the validity of each reuse application. As part of this analysis, the cost of clean makeup water must be considered. Currently, filtered water is supplied to ORNL at a cost of approximately \$0.13 per cubic meter. If the 2.3×10^5 cubic meters of water discharged from the LLW system were able to be reused, its value would then be approximately \$30,500 per year.

There are numerous applications possible for recycled water. To identify many of these, detailed information is needed about the activities going on in the various laboratories, pilot plants, etc. There are also several major reuse applications which can be identified without benefit of such detailed information, as listed below. In general, the benefits to be gained from these recycle applications are more in terms of water conservation than in terms of significant reductions in activity releases.

- Dilution water for transfer of various sludges to the hydrofracture facility or settling ponds. Annually, this ranges from 200 to 400 cubic meters. An additional 4,000 cubic meters will be required on a one-time-only basis for transfer of gunite tank sludge. It should be noted that the ability of the ILW evaporator to concentrate waste is limited by the ability to pump the concentrates to Melton Valley. Thus, the concentration factor theoretically attainable in the evaporator is diluted to permit transfer. In addition, some water is needed to flush the transfer lines clear following transfer and this effectively creates additional dilution flow.

- Flush water for decontamination projects. The precise amount would be dependent on the type of facility being decontaminated and the decontamination method being used. Tables B.3-4 and B.3-5 summarize recommended water usage requirements for various decontamination methods for different types of surfaces. It is also recommended that recycle water not only be used for large D&D projects, but also for the large number of various equipment items now being routinely decontaminated in Building 3517.

- Steam supply to ILW and LLW evaporators and miscellaneous waste transfer steam jets. Approximately 1.1 x 10^7 kilogram of steam are used annually for these purposes. Use of recycle water as boiler feed would require addition of a small electric boiler (2,300 to 4,600 kilograms per hour) to prevent contamination of the main steam plant. Once the system is filled, an additional 0.5 to one liter per minute would be required on a continual basis to make up for losses due to blowdown and steam jet eductor operation.

A complete evaluation of possible recycle applications for processed LLW is estimated to require three months to complete and up to 1,000 engineering manhours.

2. If the results of the reuse applications study are favorable, design/ construction of a water storage/distribution system would then proceed. Two system concepts would be feasible for this. The first would be construction of a lined reservoir. The cost and construction schedule would be dependent on the size needed. If all of the process effluent were to be recycled, a 1,350 cubic meter reservoir would adequately serve the laboratory's peak daily usage rate (750 to 950 cubic meters per day). Based on data given in Section 3.2.2 of Appendix B a reservoir of this capacity would cost $100,000 and take six to eight months to design and construct.

   The second alternative would be to use the existing gunite tanks, provided they can be adequately decontaminated as part of the current decommissioning program for these tanks. Two of these six tanks would provide 1,350 cubic meters of storage capacity. Lining of two tanks would cost approximately $10,000. Depending on what additional piping would be required to transfer water into these tanks, an additional $10,000 to $20,000 would be expended. The schedule for installation of the tank linings and transfer piping is estimated at six to nine months (after the tanks have been decontaminated).

   The cost of a system for transferring recycle water from the storage reservoir or tanks back to the various users will be largely dependent on what the reuse applications will be and how much of the existing water distribution piping system (if any) can be used for this purpose. Installed cost of buried, small diameter PVC piping is currently about $13 to $16 per meter, if the area is not congested or contaminated.

Installation of recycle water transfer piping should be coordinated with the schedule for replacement of the ILW and LLW collection system piping discussed in Appendicies B 3.2.1 and 3.2.6. Since these lines will be run between many of the same end points, costs could be shared for trench excavation, which represent 40 to 50 percent of the installed cost given above for PVC piping.

3.2.6 Liquid ILW Collection

3.2.6.1 Discussion

The liquid ILW collection subsystem for ORNL is shown schematically in Figure A.2-4 and A.2-8. The system is composed of a large amount of buried, small bore drain piping that collects the intermediate level wastes from hot cells, fume hoods, etc., within the numerous facilities on the reservation. The wastes drain by gravity to intermediate holdup tanks that are buried at various locations. From these tanks, where the pH is adjusted by a sodium hydroxide heel in each tank, the wastes are pumped by means of steam jet eductors or pumps to a double-walled collection header leading to the ILW evaporator feed tanks. Numerous problems exist with this arrangement. Upstream of the collection header, all of the piping is old, single walled pipe buried directly in the ground. Much of this piping dates back to the 1940's and early 1950's, and the great majority is 304 SS with no cathodic protection. In some areas, the piping is low enough to be in direct contact with the groundwater much of the time. Between the source generator buildings and holdup tanks, the piping is exposed internally to a wide range of acid/caustic conditions because it is not until the waste reaches the holdup tanks that sodium hydroxide is added. Several lines have been found to be leaking and have been abandoned. It is not possible to precisely determine the condition of the entire system because not all lines are isolatable and no leak detection provisions were included when the piping was originally installed. However, considering the age of the piping and the conditions to which it has been exposed, it is reasonable to assume that much of this piping has either failed or has the potential for failing in the near future.

The intermediate holdup tanks are in much the same state as the piping. These tanks are all single walled, stainless steel vessels buried in the ground in the manner shown in Figure A.2-10. The tanks are not accessible for inspection. Leakage can only be detected by sampling any water collected in the French drain arrangement beneath the tanks. Several of these tanks have already failed and been abandoned. The potential for failure of the remaining tanks is considered high.

The ILW collection subsystem collects liquid wastes of varied radioactive content. The average waste activity is below 0.1 curie per liter; however, the activity content can be as high as 5.3 curies per liter. The uncontrolled, unmonitored release of liquids having radionuclide concentrations in this range would not be a practice that is ALARA and might also result in a violation of established discharge limits at the site boundary. Because of the aforementioned design features and deteriorated condition of the ILW collection subsystem, the potential for such a release in the near future is considered to be high. Therefore, this problem is classified as a Priority Level I item.

3.2.6.2 Recommended Actions

1. The problems with the ILW collection system have been recognized for some time and a project is now in the feasibility study phase to correct these deficiencies (Swinney, C.S.). Initially, the scope of this project was to consolidate the holdup tanks by replacing 19 tanks of various sizes with six larger capacity tanks and to replace the discharge lines for these tanks with double-contained lines. The new replacement tanks will each be stainless steel and located in a stainless steel lined underground vault for secondary containment as shown in Figure A.2-11. The tanks and vaults will be seismically designed. The piping will be 304L stainless steel centered within an outer 304L stainless steel pipe serving as secondary containment as shown in Figure A.2-14. The annular space between the two pipes will be

blanketed with nitrogen at 150 psig and the nitrogen will be monitored so that if a leak occurs, it will be indicated by a flow of nitrogen (either into a leaking inner pipe or out of a leaking outer pipe).

The steps proposed in this conceptual design would resolve the problems described above. Therefore, this project (with or without the modifications discussed below) should be funded and implemented as soon as possible. The estimated schedule for this project (without the modifications discussed below) is 36 months and the estimated cost is $15 million.

2. Very recently, two major changes have been suggested in the scope of work for this project. The first is to include the gravity drain lines from the source generator buildings to the holdup tanks in the replacement program. This modification is strongly supported because the holdup tank feed lines, which are a significant portion of the total system, are subject to the widest fluctuation in pH conditions (pH is not adjusted until the waste reaches the holdup tanks). Thus, these lines would be expected to deteriorate more rapidly than any other lines.

The second scope modification entails further consolidation of the holdup tanks and inclusion of the tanks in Melton Valley in the project. As now proposed, all tanks in Bethel Valley would be replaced by two centrally located, redundant, 45,500 liter tanks each of which would be in an underground vault just west of Building 3500. A plot plan showing preliminary location of these tanks is shown in Figure B.3-3. The design is identical to that for the other tanks proposed initially. However, because these two tanks would collect all wastes from Melton Valley, additional features should be incorporated to meet ALARA criteria. The two tanks should be in separate cubicles and the piping gallery for the inlet lines should be segregated into separate shielded areas for the piping, valves and instruments associated with each individual inlet line.

In Melton Valley, the proposed modification would segregate the high flux isotope reactor (HFIR) facility wastes from those of the TURF and TRU facilities by replacing existing tanks T1 and T2 with one new, doubly contained tank that would only collect HFIR wastes. Tank WC 20, which is relatively new and considered to be of acceptable design, would then be used only for TRU-TURF wastes.

The additional consolidation of holdup tanks now being proposed is also strongly endorsed, since this will reduce the number of locations where relatively high activity waste will be concentrated underground, thus reducing the consequences of potential accidents. From an ALARA standpoint, this approach is also superior since, with less tanks, there will also be less instrumentation and equipment to maintain and repair in a radioactive environment. Finally, from a cost standpoint, the savings accrued by using fewer tanks will offset part of the added cost of replacing all piping upstream of the tanks. It is estimated that the additional cost of all of these modifications, including escalation for a one- to two-year delay in the start of the project, will be \$10 to \$15 million above the original estimate of \$15 million.

3. Because of the magnitude and relative importance of this project, it is recommended that a formal study be made of several additional alternatives before design proceeds further on the approach presented above. Because of the complex nature of the collection system, it is not readily apparent that one alternative is significantly superior to the others without performing such a study. Since an alternatives evaluation must eventually be performed as part of the EIS for this project, conducting such a study at this stage does not represent additional work from an overall project standpoint.

One of the most important subjects to consider in this evaluation is the expected design life of the piping system. The replacement project, as presently proposed, will not reduce the exposure of the piping internals to a wide range of chemical and pH conditions. The external surface of the outer guard pipe will still be in contact with the soil and ground water, although it will have cathodic protection. If failures were to occur in the new system, repair would be extremely difficult and costly. Down time of the system while making repairs would be lengthy because of the lack of any provisions to simplify such tasks. Consequently, exposures to personnel repairing the piping could be high and R&D work in the area served by the faulty piping could be halted for an unacceptable period of time. Considering these ramifications, it is important to know with a good degree of certainty how well the piping will hold up under the conditions to which it will be exposed. To make this determination, reliable information on corrosion under these conditions is needed. There are numerous sources of corrosion data in the literature. It is recommended that a thorough review of this literature be conducted in order to identify data that correlates most closely to ORNL's soil and waste conditions. Typical data showing the relative corrosion resistance of high alloy steels buried in various types of soils for nine years is given in Table B.3-6. This data shows that, without cathodic protection, these alloy steels will exhibit substantial pitting, and even complete puncturing, in less than nine years under certain soil conditions. Table B.3-7 contains similar data on several stainless steels exposed to various chemicals and again shows the potential for severe pitting or failure under certain conditions.

The usefulness of published data in determining the design life for piping at ORNL is somewhat diminished by the fact that the chemical nature of the wastes being handled varies widely and is often unknown. Therefore, it is recommended that this data be supplemented by field measurements on representative samples of buried piping from the ILW system. In order to minimize interference with other laboratory operations wherever possible, the pipe sections exhumed for examination should be in runs that are no longer being used. The data gained from these field measurements, together with data from the literature, should provide a reasonably accurate basis for conservatively determining the life expectancy of the new piping system. These results can then be used to evaluate the adequacy of the present design and other alternatives from this standpoint.

There are several alternative collection schemes that should be evaluated. For each scheme, consideration should be given to the following points: a) technical feasibility; b) operating safety; c) ease of operation; d) maintainability and amount of normal maintenance expected; e) constructability; f) construction schedule; g) impact of construction on laboratory operations; h) exposure during construction, operation, maintenance and repair; i) aesthetics; j) construction costs; k) operating and maintenance costs; l) replacement costs if alternative must ever be replaced in whole or in part; and m) eventual decontamination/ decommissioning costs. The alternatives that should be included in this evaluation are:

a. Use of more corrosion-resistant piping material - Rather than 304L, use 316L, Incoloy 800 series, Inconel 600 series, Alloy 20, or other high grade material for inner pipe.

b. Use plastic lined pipe - Slip line flexible, high-pressure, chemical-resistant plastic pipe inside cathodic protected, larger diameter 304L stainless steel guard pipe. Guard pipe to be tied into stainless steel lined, leak-tight manholes spaced as necessary to serve as pull boxes. Provide isolation valves at manholes for leak testing sections.

c. Elimination of all buried intermediate holdup tanks in Bethel Valley - In the lowest elevation of each source building, retrofit double-walled sump several hundred liters in capacity. The sump liner should be replaceable, and each sump should have redundant sump pumps or eductors for recycle/sampling and transfer to ILW evaporator feed tanks. The sumps should be sealed and vented to the hot off-gas header in building. If necessary to protect the material selected for the liner and drain piping, provide a sodium hydroxide heel in each sump for pH control. The double-walled drain header should be buried as near to the surface as permitted by shielding requirements in order to keep the line out of the ground water, to minimize construction schedule/costs, and to simplify future exhumation if ever required. In lieu of double-walled pipe, evaluate using plastic or stainless steel drain lines in concrete chase. The top of the chase should be flush with grade and removable for inspection or replacement of the drain lines. Isolation valves would be required for leak testing. Figure B.3-4 is a conceptual illustration of the sump and pipe chase arrangement.

d. Merge LLW/ILW systems into one collection/processing system - As discussed in greater detail below, there may be significant advantages to combining the ILW and LLW systems. In summary, the major advantages would be:

(1) Reduced installation costs for new collection systems, since only one system would be needed.

(2) Reduced maintenace costs, since only one system would have to be maintained.

(3) Reduced activity releases by processing all wastes through both the evaporator and scavenging precipitation - ion exchange (SPIX) process.

A detailed study of this consolidation must also consider real or potential disadvantages, as discussed in more detail below. In summary, these are:

(1) Potential need for greater evaporative capacity. This is a complex issue with many facets to it. Without elimination of inleakage and rainwater to the LLW system, there is no question that evaporation would not be feasible because of the large amount of evaporative capacity needed. With these reductions, justification for some additional evaporative capacity would be made in terms of increased VR factor (by going to a forced circulation evaporator/crystallizer, calciner or other advanced evaporative process) and the potential need for greater evaporative capacity to handle anticipated chemical decontamination solutions from D & D of surplus facilities (either the chemistry or activity of these D & D wastes may preclude processing via the SPIX system).

(2) Potential increase in operating costs. This is again somethin that could be either a pro or con, depending on conditions. A

detailed cost comparison of evaporation ion exchange, and any combination of these processes is very dependent on waste chemistry and quantity - factors that are still not well defined and which are very dependent on the system fixed selected. The impacted of the proposed new flow sheet for the SPIX on overall operating costs adds further unknows which must be resolved before it can be determined what the overall impact on operating costs would be. As discussed in Appendix B 3.2.1, the gravity drain lines for the LLW system are in need of major repair or replacement to stop groundwater inleakage and the collection basins need to be covered to eliminate collection and treatment of precipitation. In many instances, the LLW and ILW collection drain lines from a source generator building run parallel to each other for hundreds of meters before branching off to the LLW equalization basin or the ILW evaporator. Combining these lines could save 25 to 50 percent of the costs for replacing these lines individually. Moreover, operation and/or maintenance costs for waste collection could be cut substantially by this consolidation.

Whether or not these two collection systems could be combined in whole or in part depends on the results of a detailed reevaluation of the design criteria and philosophy originally used as a basis for segregating LLW and ILW wastes. As originally conceived, LLW was collected and sent to basins from which it was pumped to either a modified water-softening process for removal of radionuclides or directly to White Oak Creek. The sludges from the water treatment plant were disposed of in open ponds or pits. In 1975, a new LLW waste processing system called a scavenging precipitation ion exchange process was placed in service. The three major outputs from this process are purified water, resin regenerant solutions and clarifier sludge. Presently, the regenerant solutions are sent to the ILW system evaporator and the sludges are sent to open ponds. As discussed in Appendix B.3.2.3, open pit disposal of the process plant sludges is not in conformance with DOE policy and should be discontinued once the existing disposal ponds are filled. Regardless of what modifications are made to the LLW processing stream to alleviate this problem, the end product will most likely be disposed of by some type of encapsulation process. Thus, the new flow sheet for LLW will look very much like that for the ILW system. Figure B.3-5 graphically compares the flow sheets for separate LLW and ILW systems with that of a combined system. The question then becomes whether or not it is economical to continue to process ILW and LLW wastes separately. Generally speaking, evaporation is more economical than ion exchange as the waste input conductivity increases. In cases where the ion exchanger regenerant solutions must be processed further (such as by evaporation and hydrofracturing in the case of ORNL's LLW system regenerant solutions), the balance is swung further in favor of evaporation. If the front-end clarifiers are removed from the LLW system, as is now being considered, evaporation would have an even greater advantage over ion exchange, since the number of regeneration cycles for the ion exchange vessels would increase at least fourfold (according to preliminary estimates). To this must be added the increase in cost of resin replacement due to the shorter life expectancy, the cost of depleted resin disposal, the cost of a larger filter system upstream of the ion exchange beds to take the place of the clarifier/precipitator for particulate removal, and the cost of disposal for the cartridges or sludges from this additional filtration capacity.

Equally important in evaluating the merits of combining the ILW and LLW systems is the ability to process the combined flow rates of these two systems by the ILW evaporators. The two existing evaporators, if operated simultaneously, can process 75 liter/min. ILW inputs now average 9.5 to 11.5 liter/min and 8×10^4 μCi/liter. LLW inputs are normally in the range of 1.5 to 1.9×10^4 m^3/month (340 to 435 liter/min) and 3.7 to 8.5×10^{-2} μCi/liter. Based on these figures, the ILW evaporators would not be able to handle the additional wastes from the LLW. However, this is somewhat misleading in that a large percentage of the LLW is unwanted inleakage that would be eliminated if the system is upgraded. Inspection of Table A.1-9 indicates that in 1979, 28 percent of the LLW system inputs originated from tank farm area drainage. As these tanks are deconned and decommissioned, there would no longer be any need to collect this drainage. A failed section of drainage piping between MH 112 and MH 114 accounts for another 13 percent. If repaired, this would further reduce the input rate.

In addition to the main tank farm, there are 16 smaller tank farms scattered about in Bethel Valley with vault drainage systems connected to the LLW system. There is no data on how much groundwater is added to the LLW system from these tank vaults, and in many cases, it would be difficult to measure the quantity from these sources because the drain lines are often headered into trunk lines picking up other sources before a flow monitoring station. However, the total distance around the perimeter of these 16 tank vaults is about 25 to 50 percent of that for the main tank farm; and if it is assumed that the amount of groundwater collected is directly proportional to the perimeter length, then it can be assumed that an additional seven to 14 percent of the total waste inventory originates from these vaults. If all of these tank vaults were replaced with a centralized, double-walled tank as proposed by ORNL Engineering, then the waste inputs would be further reduced by another 14 percent. Elimination of all these extraneous sources would reduce the maximum input rate from 435 liter/min to 197 liter/min.

Two other sources of unnecessary inputs to the LLW system that should be considered are groundwater intrusion via leaking pipe sections and precipitation inleakage via leaking manholes. There is no data on the quantity of incoming water from these sources. However, the inleakage in the section of piping between MH 112 and MH 114 represents 13 percent of the total LLW system inputs, and yet this 20.3 cm diameter by 75/m long section of pipe is less than 0.1 percent of the 9800/m of 15.25 cm diameter (or larger) piping in the LLW collection system (there is also over 3000/m of piping 10.2 cm in diameter or less). Therefore, it is conceivable that unidentified inleakage from the remaining piping and some 250 manholes could represent much more than 13 percent of the total system input. Whether or not this will be enough to bring the total inputs below the 75 liter/min processing limit for the ILW evaporators (i.e., once the leaks in the piping and manholes are eliminated) cannot be determined before a system water balance is performed, as recommended in Appendix B.3.2.1.

Once the data from this water balance is known, two other factors must be considered in evaluating the merits of combining the ILW and LLW collection systems. The first of these is the possibility of diverting all LLW inputs directly to White Oak Creek after eliminating the two major sources of activity as discussed in Appendix B.3.2.1. If this course of action were to be selected, then combining of the ILW and LLW collection systems would not be necessary. The second factor to consider is the impact of future D&D projects and future volume reduction systems on the liquid waste processing system capabilities. More detailed study of the D&D projects, as recommended in Appendix B.3.5.2, may show that: a) the excess capacity of the existing ILW evaporators will be needed to handle decon waste solutions; or b) that the existing evaporators are either too small to handle these wastes or not designed to handle them safely (i.e., without material failure, plugging, foaming, etc.). In either case, the handling of the D&D wastes would affect the outcome of any evaluation of processing both ILW and LLW wastes through the ILW evaporator. The type of VR equipment installed in the future could also affect the subject evaluation. For example, if a fluidized bed calciner were installed that could handle both wet and dry wastes, additional evaporation capacity might be justified in order to volume reduce the low-level liquid wastes enough to enable the calciner to handle them (the commercially available wet waste calciners have a process capacity of only 7.5 liter/min).

As indicated by the above discussion, a proper evaluation of the feasibility of merging the ILW and LLW systems is very complex and is dependent on, or significantly affected by, the outcome of several other studies or data gathering projects. Once the results of these other projects are known, the alternatives evaluation recommended here could be completed in about six months. The engineering time required to complete this evaluation, including exhumation and inspection of sample pipe segments, is estimated to be 2,000 manhours. Cost of exhuming sample piping segments is approximately $30/m, assuming no piping bypasses are required around the piping that is removed for inspection.

3.2.7 Liquid ILW Sludge Disposal

3.2.7.1 Discussion

Highly radioactive concentrates (normally 0.25 to 0.5 curies per liter) are produced as a result of evaporation of ILW. Since 1965, these evaporator bottoms have been routinely disposed of by hydrofracturing a waste/cement grout mixture into semi-impermeable Conasauga shale formations at a depth of 200 to 300 meters below the surface of Melton Valley. Although over 6.8 million liters of waste grout containing 550,000 curies of radionuclides have been safely disposed of in this manner without incident, there remain several technical and regulatory issues not fully resolved. A final safety analysis report will soon be issued for the hydrofracture facility that should put these concerns to rest so that hydrofracturing can continue to be used for disposal of all future ILW at ORNL. However, should any of these concerns not be resolved satisfactorily and hydrofracturing is discontinued, operation of the laboratory would be severely disrupted until an alternate means of disposal or storage of these wastes is available.

1. Technical Issues

The technical feasibility and inherent safety of hydrofracturing has been shown in several previous evaluations of the process and have been demonstrated in actual operating experience. However, as discussed in the Final Environmental Impact Statement (FEIS), there are several possible accident conditions which could result in exposures to the general public and/or contamination of the environment. These include:

a. Rupture of Wellhead

Every precaution has been taken to prevent such an occurrence. However, in the event that a wellhead were to rupture, this would result in a grout bleed-back volume of as much as 95,000 liters. A 150,000 liter concrete pit is provided as an emergency collection basin for such an occurrence and should prevent contamination of the environment. However, operation of the hydrofracture facility following such an accident would be hampered by the high radiation levels around the wellhead cubicle and this basin. Clean-up would be an expensive, high exposure, time consuming operation.

b. Vertical Fractures/Waste Migration

The likelihood of a vertical fracture occurring has been thoroughly studied and determined to be quite low. In some of the early work with different waste/grout formulations, multiple grout sheets were formed, possibly as a result of dehydration of the grout mix as it extended out into the fracture, thus inducing formation of new fractures starting back at the well bore. As a result of extensive testing, grout mixes and operating procedures have been developed that will minimize the possibility of such occurences. In addition, the fact that the secondary fractures were horizontal strongly supports the conclusion that hydrofracturing at the ORNL site will continue to occur in a horizontal mode.

Concern over the possible migration of the grout along existing vertical joints or faults to new bedding planes above or below the host shale formation, and dilatation of the bedding plane beyond the grout zone with resultant migration of fluids along these dilatations to pre-existing vertical faults, has been raised by the EPA and others (Liverman, 1977). Although field data indicates that there are no known vertical faults in the area of the hydrofracture facility to allow such vertical migration, their existence cannot be ruled out. Nor can it be stated with complete certainty that hydrofracturing itself will not create complex, composite stress that will in turn create vertical fractures and resultant upward migration of waste.

Acknowledging these possible mechanisms for migration of the grout mixture (or excess liquid in the case of improper proportioning of waste to cement), a thorough investigation of the consequences has been conducted. For the case in which the grout reaches the groundwater table and then forms a horizontal grout sheet, calculations have shown that the inherent ion exchange capacity and impermeability of the shale would combine to ensure that the activity concentrations of Sr-90 and Cs-137 would be near background before these isotopes could migrate to the surface. However, actual experience with leaching of radionuclides from existing burial grounds in Melton Valley do not bear this out, possibly because of the existence of many small faults that allow the groundwater to move more rapidly through the shale. These fault lines can even cause movement of groundwater in directions opposite to normal drainage pathways, as is evidenced by the fact that radionuclides from SWSA-3, which by inspection of the topography should drain into White Oak Creek, have been detected in Racoon Creek.

The worst possible result of a vertical fracture would be eruption of the grout sheet into the bed of a creek leading to the Clinch River. Calculations indicate that for this improbable event, there could be a temporary increase in the Sr-90 concentration in the Clinch River to twice MPC.

All existing data indicates that any of the above events are highly improbable. Furthermore, analysis of these events has shown that the hazards to the general populace from their occurrence is relatively small. Nevertheless, the resultant long term contamination of the environment, costs of cleanup efforts, and impact on public acceptance of such practices would undoubtedly be enough to cause an immediate and, most likely, permanent halt to further hydrofracturing operations. Again, other activities at the laboratory would be severely restricted if this ban in turn required limitations on ILW production until an alternate disposal method became operational.

2. Regulatory Issues

There are several regulatory issues, related to both existing and future regulations, that may have an adverse effect on operation of the hydrofracture facility. These include the following:

a. TRU Limitations

DOE Manual, Chapter 0511 requires that waste containing more than 10 μCi/kg of transuranic (TRU) waste be stored in an easily retrievable form for at least 20 years. As shown in Table B.3-8, to date at least four grout inections have not met this criteria by hydrofracturing well over 10 μCi/kg of total TRU waste. For the four categories of future waste to be hydrofractured, Table B.3-8 shows that this limit would also be exceeded.

In order to satisfy the 10 μCi/kg limit, Table B.3-8 shows that substantial dilution of the four future waste categories would be required. For example, the gunite tank sludge volume would have to be diluted until the volume as a grout mixture is 108 times the volume of grout mixture with no TRU limit. This would not only increase the cost of hydrofracturing to the point that it would no longer be economically attractive, but might also result in the storage capacity of the shale formations at the new hydrofracture facility being exceeded.

b. EPA Drinking Water Standards

In its review of the FEIS for the hydrofracture facility (Liverman, 1977), the EPA has stated that "if radioactive wastes are disposed of by utilizing the shale fracturing process, ... a state permit will be required pursuant to Sections 1421, 1422, 1423 and 1450 of the Public Health Service Act, as amended by the Safe Drinking Water Act." DOE's response to this has been that this Act is not applicable to ORNL's hydrofracturing operation because of the physical separation from public drinking water supplies afforded by the restrictions on access to the ORNL reservation. Should the EPA's interpretation of this Act prevail, the fact that EPA has rated ORNL's hydrofracturing proposal as "ER" (Environmental Reservations) and classified the draft EIS as "Category 2" (Insufficient Information) would indicate the potential for lengthy delays in obtaining the necessary permits for proceeding with hydrofracture injections.

c. NRC Regulations

At present, the NRC has no regulatory jurisdiction over DOE radwaste management operations. However, in its review of the feasibility of assuming such authority (USNRC 1979), the NRC has specifically stated that it presently lacks the expertise to judge the technical adequacy and safety of ORNL's hydrofracture operations and that a significant portion of the cost of assuming this authority would be spent in gaining such expertise. Implicit in this statement is the conclusion that lengthy delays could be expected in obtaining an operating license for the hydrofracture facility if it were to come under the jurisdiction of the NRC.

d. Interface with National Policy on HLW Disposal

In 1976, DOE, through the Office of Nuclear Waste Isolation (ONWI), established the National Waste Terminal Storage Program (NWTS) to provide technology and facilities for the terminal isolation of high level commercial wastes by disposal in stable geologic repositories deep underground. In conjunction with this, the NRC has been charged with the responsibility for developing performance criteria for solidified high-level radioactive waste and the EPA has been chartered to develop generic environmental protection criteria for radioactive waste management. Through these and other efforts, a uniform national policy has slowly begun to take form for the ultimate disposition of both commercial and defense related HLW.

As discussed more fully in Appendix B.3.2.8, current definitions of HLW and LLW make it difficult to determine where ORNL's unique ILW category fits into this overall plan. Indeed, whether it should fit into this plan or continue to be considered as a unique, "one time only" situation is itself unclear. However, there does seem to be considerable sentiment towards establishment of a national policy that would recognize the benefits of considering the hazards of radioactive wastes on a multi-tiered basis as suggested by ORNL's handling of intermediate level waste. For instance, in its final report to the NRC on solidification of HLW (Roy, 1979), the National Academy of Sciences stated "that defense wastes which are relatively low in radioactivity and thermal power density can best be solidified by low-temperature processes, such as those used to produce cement-matrix," as opposed to the use of more sophisticated techniques such as encapsulation in glass. The Academy also found "that many solid forms are likely to be satisfactory for use in an appropriately designed system." The benefits of such a multi-tiered approach on a national level have also been alluded to in comments on the ILW FEIS by the US Department of the Interior, the Exxon Nuclear Company, Inc., the Ohio EPA and the NRC. Reference is also made by Argonne National Laboratory (ANL 1978) to the possible use of hydrofracturing for disposal of intermediate levels of waste generated in the decommissioning of Nuclear Fuel Service's West Valley Site. And finally, in its recent policy statement on disposal of nuclear waste (USDOE 1980), DOE has considered hydrofracturing as a feasible (though not prime) technique for disposal of certain categories of HLW.

Should DOE commit to a program to demonstrate the usefulness of ORNL's hydrofracturing technique at other sites, further R. & D. work would have to be undertaken to resolve concerns raised by other agencies (such as the EPA) as well as by DOE itself (USDOE 1980). As suggested by the US Dept. of the Interior (Liverman, 1977) this might entail addition of batteries of monitoring wells, rock stress measurements, etc., to develop a more general, less empirical model of hydrofracturing that would allow evaluation of this technique for other sites. Setting up such an R. & D. effort would be time consuming and may be cause for short term delays in startup of the hydrofracture facility. This again would have a negative effect on production of ILW and consequently on operation of the Laboratory.

The technical and regulatory issues discussed above are not ones that would pose any near-term threat to public health and safety or the environment. This area has therefore been classified as a Priority

Level III item. However, should any of the regulatory issues discussed above not be resolved in favor of ORNL, the resultant effects on operation of the Laboratory would cause upgrading of this item to Priority Level I.

3.2.7.2 Recommended Actions

1. Addendum III.F to Section 3.5 of the FEIS indicates that the concentration of uranium and TRU waste in specific injections may approach 100 μCi/kg, but that the overall average, taking into account the relatively small fraction of the disposal zone represented by the grout sheets, would be well below the 10 μCi/kg limit. Operation of the hydrofracture facility should proceed on the basis of taking credit for this dilution.

2. Plans should be developed and carried through the conceptual design stage for an alternate above ground solidification and storage process for ILW. Design, construction schedules and costs for this alternative should be such that the system could become operational in a short period of time (six to 12 months) in the event that hydrofracturing is delayed or permanently halted. The feasibility of developing a system that could handle the needs of both the ILW system and the by-product of future SRW volume reduction processes (incineration ash, etc.) should also be considered.

   Two schemes have been identified that would satisfy the criteria listed above. Scheme 2a would involve maximum utilization of the cement solidification facilities now being constructed for the new hydrofracture facility. The existing system would be modified by adding a three-way valve downstream of the waste/cement mixing tub to divert the grout mixture to a portable container. To accommodate this small batch operation, a recirculation line would be needed to direct concentrate back to the storage tank while a small amount of clean flush water is pumped through the waste feed pump discharge line into the portable container at the end of each filling operation. To verify the end product characteristics, instrumentation would also be needed to measure the proportions of liquid waste and cement in the mixture. These changes to the process flow sheet are shown schematically in Figure B.3-6.

The portable liner would be located in a lead or concrete shield mounted on a truck pulled up to a fill connection point immediately adjacent to the mixer cubicle. This approach would minimize the construction schedule for the modification by requiring only the addition of a concrete mat and metal sided building for containment and weather protection.

In order to satisfy the schedule and cost restraints for installation of the alternate solidification method, initially it would not be feasible to consider installation of a thin film evaporator, calciner or other drying device to reduce the volume of waste feed to the grout mixing process as proposed in the FEIS. This would result in some loss of packaging efficiency. ORNL's ILW is a complex mix of five or more alkaline salts, but the primary constituent is $NaNO_3$. The concentration of $NaNO_3$ ranges from 1$\underline{M}$ to 3$\underline{M}$ (8 to 24 wt. percent). Experimental work at Hanford (Allen 1977) indicates that a product of good strength and abrasion resistance can be achieved up to sodium nitrate concentration of 44 percent by weight in the final product. At this concentration, the volume of solidified waste would be lower than the corresponding volume for a 1$\underline{M}$ feed solution of $NaNO_3$ by a factor of 16.7. Thus, by preconcentrating the waste, the required engineered storage capacity and related storage costs would be reduced significantly. If the wastes were to be shipped off site, preconcentration would likewise reduce shipping costs and repository fees. Against this must be weighed the added cost of the volume reduction (VR) equipment and its operation, the added difficulties of handling a very concentrated slurry (75 percent by weight $NaNO_3$ prior to solidification), added shielding requirements and personnel exposures, added delay in system availability, and added concern over heat generation in the solidified product.

It is estimated that without additional VR capability, the initial capital costs involved in modifying the hydrofracture facility to permit solidification in portable containers would be less than $250,000 and would take six to 12 months to complete. If VR capability was included, the modifications would cost over $5 million and take two to three years to complete.

For Scheme 2a, the solidified product would be packaged in a transportable container. Many size, shape and design variations are possible, but for conceptual design purposes, a rectangular, stainless steel container of approximately 2 cubic meter is assumed. Containers such as this are commercially available on a 90-day delivery schedule at a cost of about $1,500 per container. These containers are stackable to five high, have built-in lifting lugs, and meet DOT shipping standards. Initially, rectangular containers would be beneficial because of the increase in storage efficiency over circular containers, offsetting somewhat the loss in packaging efficiency by not installing VR capability.

To satisfy the tight construction schedule requirements, the waste liners could be stored in precast concrete monoliths rather than in shielded storage buildings. This is similar to what has been done in other countries. Typical above-ground concrete storage containers for high activity waste at Saclay are shown in Figures B.3-7 and B.3-8. Normally, offsite shop fabrication of these monoliths would be the most cost-effective approach to take, but to remain within legal weight limitations for shipping of these cells to the site, a weight limit of 27,500 Kg would be imposed on each cell. Assuming a 0.61 m thick shield wall requirement and a cell that would house four liners that each measured 1.07 m by 1.22 m by 1.83 m high, a double-sleeved wall design would be required to maintain these within shipping weight limits. A typical arrangement for such a storage vault is shown in Figure B.3-9. The cost per vault is estimated to be $10,000 and the fabrication/delivery schedule would be less than 30 days.

If above-ground solidification of ILW is to replace hydrofracturing on a long-term or permanent basis, a comparison should be made of the technical and economic benefits of continued use of these concrete modules versus an engineered storage structure with remote handling equipment, etc., as described in the FEIS for the hydrofracture facility.

A second above-ground solidification alternative, denoted here as Scheme 2b, would be to use a commercially available, mobile waste solidification system in place of the hydrofracture waste/cement mixing equipment. Such systems are available for use with cement, urea formaldehyde and vinyl ester resin (Dow proprietary chemical). It is recommended that a system using the vinyl ester resin be employed because of the superior strength, chemical stability and long-term leach resistance of the product. These properties have been demonstrated in an exhaustive testing program (Dow 1978) and independently confirmed in research by the Central Electric Generating Board (CEGB) of England (Smitton 1981).

A typical arrangement for a mobile vinyl ester system is shown in Figure B.3-10. The solidification equipment and disposable waste liner would be mounted on a tractor trailer adjacent to the hydrofracture waste feed pump cubicle in a manner similar to the setup for the portable liner in Scheme 2a. Interface with the hydrofracture system would be minimal, requiring only the addition of a three-way valve down stream of the waste feed pump and a transfer line from this point to the truck bay.

For Scheme 2b, the liners would again be 2 cubic meter rectangular stainless steel containers. Handling and storage of the liners would be the same as described previously for Scheme 2a.

One significant advantage to the portable solidification concept is that, when in use, it could be located adjacent to either the existing ILW evaporator building or future volume reduction facilities to eliminate the need to transport concentrated waste long distances through underground pipe lines. This would be an advantage from the standpoint of safety, operating and maintenance costs, and initial capital equipment costs. By eliminating long transfers, the need to dilute the ILW evaporator bottoms would also be eliminated, resulting in an effective VR factor of three for the waste feed to the solidification system. This added VR factor would offset the higher material cost for the Dow polymer, which is currently about \$2.42/Kg (\$2.38 per liter). If VR equipment were employed, use of the Dow polymer would realize further operating cost benefits since the sodium nitrate could be incorporated into this polymer as a dry salt at a waste to binder volume ratio of 2.5 to 1.

A mobile solidification system of the type described above can be fabricated, tested and delivered in six to 12 months at an estimated cost of $750,000. Modification of the existing hydrofracture facility or ILW evaporator facility to interface with this unit is estimated to take one to three months and cost $5,000 to $10,000.

A summary of the preliminary cost estimate for each of these alternatives is given in Table B.3-9. It is recommended that an in-depth evaluation of the alternatives described above be initiated and that a conceptual design be completed only for the best-evaluated alternative. Beyond this, no work should be initiated unless it appears likely that startup of the new hydrofracture facility will be delayed indefinitely and/or that new VR systems will be installed. The alternative evaluation and conceptual design work are estimated to require six months and 5,000 manhours to complete.

3.2.8 Liquid HLW Classification

3.2.8.1 Discussion

All radioactive wastes generated at DOE regulated installations are characterized by the DOE Manual as being either high level waste (HLW) or "other liquid waste." Requirements for collection, processing, storage and disposal are determined by which of these two categories a particular waste stream falls under. As defined in Chapter 0511 of the DOE Manual, liquid HLW is "the aqueous waste resulting from the operation of the first-cycle extraction system, or equivalent concentrated wastes from subsequent extraction cycles, or equivalent wastes from a process not using solvent extraction, in a facility for processing irradiated reactor fuels." "Other liquid waste" is defined as "liquid waste not within the definition of high-level liquid waste" and is commonly referred to as low-level waste (LLW).

DOE's definition of HLW is qualitative and rather loosely worded. In order to apply the rules governing management of HLW, each DOE site has had to develop more specific, quantitative criteria for what is HLW and what is not. Because of the vagueness of DOE's definition, each site's interpretation has been somewhat different from the others, resulting in, at times, some conflict in the way similar types of waste have been managed.

The principal area of confusion and concern resulting from this is the handling of waste not defined as HLW. DOE regulations state that these wastes can be converted to either HLW, which must then "be contained and emplaced so as to be retrievable for removal and transfer elsewhere", or they can be converted to solid form and "stored in conventional burial grounds approved by the DOE." The major flaw in this is that, without a quantitative definition of HLW, it is possible for non-HLW containing greater concentrations of hazardous isotopes than some HLW to be "stored" in a manner providing far less protection than would be afforded if it were classified as HLW.

At ORNL, very little of the waste that is generated falls under the above definition of HLW, but much of it contains certain isotopes (primarily Sr-90 and Cs-137) in sufficient concentrations to merit concern over use of conventional shallow land burial techniques for disposal. Recognizing this problem, but not wanting to consider this waste as HLW, with the attendant costs of special containment and retrieval capabilities, ORNL has elected to establish its own unique intermediate level waste (ILW) category for handling these higher activity wastes. Although this waste category has been accepted by DOE for ORNL's unique circumstances, problems again arise over interpretation and use of the term because it also is defined in a qualitative and somewhat arbitrary fashion. There is no mention given to this term in the Chapters of the DOE Manual governing radioactive waste management. In a 1973 AEC planning document (Pittman 1973), ILW is defined as "liquid wastes in a processing or interim status; they must eventually be solidified, or treated to yield high- and low-level liquid-waste fractions." Interestingly enough, even the environmental impact statement for management of ORNL's ILW does not attempt to define this term rigorously.

The net result of this lack of specific criteria for defining waste types is summed up best by the comparison of DOE HLW, commercial HLW, and ORNL ILW presented in Table B.3-10. Two significant points are illustrated by this table. First of all, the two isotopes that the NRC has selected as being the benchmark by which to measure quantities of HLW are Cs-137 and Sr-90, rather than longer lived isotopes such as Pu-239. This is significant because most of the activity in ORNL's waste is also Cs-137 and Sr-90. Secondly, this table shows that the activity level in ILW generated by ORNL is comparable to the average activity level in liquid HLW generated at other DOE sites. Considering these similarities, the marked difference between the management of these wastes at ORNL and other DOE sites tends to weaken the credibility of a uniform national waste management policy.

The lack of a precise definition for HLW is a management concern that could effect project schedules and costs in the long run, but is unlikely to have a serious effect on safety or the environment. Therefore this item is given a Priority Level III classification.

3.2.8.2 Recommended Actions

It is recommended that a study be conducted to develop a precise, quantitative definition of HLW based on concentration guides for safe storage or disposal, similar to the hazard index used by the U. S. Department of Transportation to determine the packaging requirements for different levels of waste during shipment. It is recommended that a definition be developed that would allow for multiple levels of protection, based on the relative danger the waste poses to man and his environment. Such a waste classification system is currently being developed by the NRC for disposal of commercially generated wastes and it is possible that this scheme could be applied to DOE wastes in whole or in part (Rodgers 1979, 1978). The study should include a detailed pathways analysis that would provide the technical justification for selection of a particular level of protection for a particular level of waste on a generic basis, applicable to any present or future DOE site. Where appropriate, the study should identify the need for any additional R. & D. work or analysis to completely define or justify the waste classification system.

The schedule and cost for such a study is dependent to a large degree on how closely the effort follows similar work being funded by the NRC for commercial waste classification. An entirely independent effort paralleling that of the NRC's is estimated to require one year to complete and a commitment of 10,000 engineering manhours.

3.3 GASEOUS RADIOACTIVE WASTE (GRW) MANAGEMENT

3.3.1 GRW-Collection/Discharge

3.3.1.1 Discussion

The present off-gas and cell ventilation system at the base of Stack 3039 is in a general state of disrepair. Much of the ductwork is no longer leak tight and allows unmonitored release of gaseous activity from sections under positive pressure. Much of the equipment in the system was installed 20 to 35 years ago. Consequently, much of the equipment is outmoded and inefficient, system reliability is low, and standby capacity is minimal or non-existant. Because the system was installed over 20 years ago, there is a general lack of ALARA philosophy incorporated into the general design and arrangement of the system. The system is particularly deficient with respect to accessability for operation and maintenance under both normal and post-accident conditions.

As shown in Figures A.2-19 and A.2-20, a complex system of underground piping and ductwork is provided to collect off-gases from the various laboratory facilities and to transfer them to Stack 3039 for monitoring and discharge or to one of four other stacks serving certain sections of the laboratory complex. The condition of the collection network is unknown, but it is likely that portions of it are no longer leak tight since much of the piping in this collection system is 304 SS buried directly in the ground with no cathodic protection. As shown in Table B.3-6 and B.3-7, 304 SS can deteriorate rapidly when exposed externally to certain types of soils, or when exposed internally to certain gaseous or liquid compounds. This lack of pressure integrity could result in enough air inleakage to cause a substantial reduction in the amount of air drawn out of the source generation buildings, resulting in potentially hazardous airborne conditions in these buildings. Additionally, parts of the system are constructed of concrete chases with joints and removable roof slabs which allow inleakage of air and water. This also reduces negative pressure in the system, exposes components to excessive amounts of moisture ladened air, and is a potential source of inleakage of water to the liquid waste collection subsystems via drain lines from these ducts.

Considering the state of disrepair of this system, the potential for future unmonitored and untreated releases to the environment is high. Therefore, this item has been give a Priority Level I ranking.

3.3.1.2 Recommend Actions

1. A large capital improvements project is currently underway to replace or improve the entire system at the base of Stack 3039, including all ductwork, some fans, all fan motors, the caustic off gas scrubber and the standby steam powered exhaust system. This corrective action is strongly endorsed. In addition, it is recommended that a formal ALARA review of the new design be conducted to ensure that the new system will provide maximum personnel protection under normal operating, maintenance and upset conditions. Such a review is estimated to require one to three months and 1000 man-hours of engineering time to complete.

2. A thorough inspection of the four other off-gas stacks and the remaining underground system of off-gas piping and ductwork should be carried out. Based on the results of this inspection, a safety and performance evaluation should then be conducted to determine the need for and extent of additional replacement and upgrading programs for these systems. As part of this evaluation, it is recommended that, as in the case of the ILW collection system (See Appendix B.3.2.6), the need for upgrading the material of construction for the ductwork/piping be studied thoroughly and that this evaluation be based on both a review of available corrosion data literature and examination of sample sections of ductwork/piping removed from the system. This evaluation should also consider the merits and need for locating all replacement ductwork and off-gas piping in an underground chase accessible for inspection and repair as shown in Figure B.3-4. In conjunction with this, and as discussed in Appendix B.3.5.1, serious

consideration should be given to coordinating any required removal/replacement effort for this underground collection system with the replacement programs being contemplated for the ILW collection system.

It is estimated that this inspection program and evaluation would take three to six months to complete and require up to 2,000 man-hours of engineering time.

3.4 DISCHARGE MONITORING/CONTROL

3.4.1 Front-End Radiation Monitoring Equipment

3.4.1.1 Discussion

1. General

The ORNL waste operation radiation monitoring system consists of radiation detectors and sampling features located at selected locations for the purpose of collecting data on releases of radioactive material to the environment. The electronic equipment which processes the signals from the detectors is located in the waste operation control center (WOCC).

The ORNL waste operation radiation monitoring system is old and requires upgrading. The electronic equipment located in the WOCC will be replaced by a modern data acquisition system. The front-end of the system, which consists of detectors and sampling features, is also old and perceived as not adequate for the purpose of monitoring releases.

Radiation monitoring philosophies have evolved over the years from an early concept of qualitative measurement of departure from normal operations, with equipment sensitivities equivalent to maximum permissible concentrations (MPC), to present criteria requiring monitoring capabilities for normal, anticipated transient and accident conditions; equipment sensitivities allowing measurement of approach to MPC; and sampling features to supplement continuous monitoring equipment.

The ORNL radiation monitoring philosophy has not kept pace with the evolution of new criteria, as evidenced by the fact that the electronic equipment which processes the signal from the detector consists of linear ratemeters with manually switchable ranges. This type of equipment does not have any dynamic range to follow transient releases; operator action is expected to keep the monitor within range in case of excessive release. This is of particular concern since, in case of an emergency, the operator is expected to perform functions at locations not in the vicinity of the equipment.

No document exists which would identify the basis for the selection of the present type of monitors, their range or response time. Considering the processes and experiments existing at ORNL, it is perceived that the present monitoring system does not have sufficient range, response time and sampling features to adequately monitor releases associated with normal, anticipated transient or accident conditions.

Specific equipment limitations have also been noted. For the purpose of description, the radiation monitoring system is segregated into two subsystems; namely the liquid and gaseous monitoring systems. The concerns associated with each of these two subsystems will be addressed separately.

2. Liquid Monitoring Subsystem

Liquid monitoring subsystems are installed in many of the manholes and effluent discharge paths to White Oak Creek, its tributaries and the Melton Branch.

The monitors are of two different types to measure alpha and beta/gamma-in-water, and are backed up by sampling features providing composite samples of the effluents for analysis purposes.

a. Alpha-in-Water Monitors

The alpha monitor detector consists of a photomultiplier tube looking at a zinc sulfide layer deposited on light pipe. The zinc sulfide layer is protected by a thick mylar film and the liquid to be monitored is passed in front and in contact with the mylar. (This type of monitor is further described in Chiles 1973).

Alphas-in-water are very difficult to detect because of the energy absorption of the water and the mylar film. Since only the alphas located in the very thin layer of water directly in contact with the mylar film are available for measurement, the impact of contamination of the mylar film is very important in determining the maximum sensitivity. Appraisal of the operational capabilities of the alpha-in-water monitor shows that the typical sensitivity of alpha-in-water is 8.75×10^{-4} µCi/cc, except for TRU waste discharge, where contamination reduces the sensitivty to 6.4×10^{-3} µCi/cc. These sensitivities must be compared to the MPC values of 3×10^{-8} µCi/cc for unidentified mixture discharged in uncontrolled area, or 3×10^{-7} µCi/cc if Ra-226 and Ra-228 can be excluded.

b. Beta/Gamma-in-Water Monitors

The beta-gamma monitors consist of GM tube detectors immersed in process water flowing through a sample cup. The GM tubes are protected against contamination by a lusteroid centrifuge tube. The process water flows continuously into the bottom of the sample cup, upward around the protected GM tube and overflows the sample cup in an inverted polyethylene bottle and returns to the process through a drain pipe at the bottom of the assembly.

The whole assembly is lead shielded to reduce the ambient background. (Further description can be found in ORNL 1964).

For this kind of monitoring, contamination appears to be a major problem. (ORNL 1964, indicates that a background of 20 cpm can be expected.) Appraisal of the monitors in the field shows that the background can be as high as 750 cpm, reducing the sensitivity by a factor of approximately 40.

When the actual field background is taken into consideration, a sensitivity of approximately 5.4×10^{-3} µCi/cc (Cs-137) is achievable. This value must be compared to the MPC value of 3×10^{-8} µCi/cc for unidentified mixture discharged in uncontrolled environment, or 3×10^{-7} µCi/cc if Ra-226 and Ra-228 can be excluded.

The difference between the sensitivites of the alpha-in-water and beta/gamma-in-water monitors and the MPC values creates a concern that radioactive liquid releases with concentration in excess of MPC could occur without detection.

This concern is not unique to ORNL because the state-of-the-art in monitoring equiment is such that liquid monitors do not have, in general, sufficient sensitivities to detect MPC values by approximately a factor of 10.

To compensate for this lack of sensitivity, sampling and laboratory analysis is normally used with a frequency based on the degree of variance of the concentration from an established norm or established by operating experience, but not to exceed one week.

The wide differences, a factor 10^4, between the ORNL alpha and beta-gamma monitors sensitivites and MPC value suggest that sampling should be relied upon heavily and that the present frequency of analysis of once a month should be backed up by appropriate analysis to support its adequacy.

3. Gaseous Monitoring Subsystem

The gaseous monitoring subsystem consists of monitors measuring the concentration of radioactive alpha particulates, beta-gamma particulates, iodine and noble gases discharged through the stacks as indicated in Table A.2-4.

a. Alpha Particulate Monitors

Airborne alpha particulates are monitored by using a vacuum pump to withdraw a representative sample of air of approximately three SCFM from the stack. The air is filtered by a step advanced Watman filter paper controlled from the WOCC. The filter paper is continuously monitored by a zinc sulfide detector. The sensitivity of a gross alpha-in-air monitor is limited by the presence of natural radon-thoron products which can be in a concentration level much higher than the MPC value of potential alpha contaminants. Appraisal of the capabilities of the alpha particulate monitor in operation shows that a sensitivity of approximately 2.9×10^{-11} μCi/cc can be achieved after eight hours sampling. This sensitivity value must be compared to the calculated maximum concentration in Stack 3039 of 4×10^{-12} μCi/cc, which represents the concentration that would result in an MPC for unidentified mixture released in an uncontrolled area after taking the stack dilution factor into consideration.

The sampling delivery system utilizes PVC tubing. This practice is not recommended, as indicated by ANSI N13.1, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," since it promotes plate-out of particulates in the 1.9 cm sample lines.

b. Beta-Gamma Monitors

Monitoring of beta-gamma particulates is performed in a manner similar to the alpha monitoring, except that GM tube detectors are used instead of a zinc sulfide detector.

Review of the capabilities of the beta-gamma monitor in operation shows that a sensitivity of approximately 1.5×10^{-9} µCi/cc can be achieved after eight hours sampling. This appears to be a somewhat poor performance due to a high background of approximately 1,800 CPM resulting (presumably) from a difficulty of shielding the detectors. This sensitivity value must be compared to the MPC value of 4×10^{-12} µCi/cc for unidentified mixture discharged to an uncontrolled environment.

Similar to the alpha monitors, the sample delivery utilizes PVC tubing of 1.9 cm for a flow of approximately 3.5 CFM, thus enhancing losses in sample lines.

c. Iodine Monitors

Iodine monitoring is performed by measuring with GM tube detectors the iodine collected on loose charcoal granules surrounding the detectors.

The charcoal granules and detectors form a sampling assembly which is connected in series with the alpha monitor in the sampling line.

State-of-the-art technology on iodine sampling makes this scheme obsolete for the following reasons:

(1). Iodine can be found in elemental or methyl form resulting in drastically different behavior. Elemental iodine attaches itself to dust particulates in air, allowing it to be collected on filters. Methyl iodine remains in a gaseous form and can be collected on charcoal, but with a low collection efficiency.

Since the iodine sampling is connected in series with the alpha monitor in the sampling line, the elemental iodine is collected on the filter of the alpha monitor and the methyl iodine is collected in the iodine samples. Since a large amount of the iodine is expected to be in elemental form, iodine monitoring in the stack is not representative of the releases.

(2) During accidental releases, it is usual that many isotopes are released simultaneously. The present collection scheme for iodine monitoring utilizes activated charcoal which can retain an appreciable amount of noble gases. The differences in permissible level between iodine and noble gases is such that noble gases may be present in concentrations several orders of magnitude higher than iodine. The utilization of Geiger-Mueller (GM) tube detectors for this measurement does not allow discrimination of the iodine against the noble gases and it is expected that in the case of a large noble gas release, the iodine monitor would respond erroneously.

(3) Bulk activated charcoal is used instead of charcoal cartridges. This makes it difficult to handle when a large amount of iodine has been collected and presents some problems for measurement in the laboratory for further analysis. This approach also limits the possibilities of shielding of the detectors.

d. Noble Gases Monitors

Noble gases are monitored by a GM tube located in a lead shielded enclosure located at the base of the stacks. Calibration of the monitor is made by checking the detector on a bench rather than in its installed position in the shielded enclosure, thus not taking into consideration the specific detection geometry and active sample volume.

e. Sampling Features

Sampling features are provided to back up the alpha, beta-gamma, and iodine monitors. These features consist of in-stack samplers equipped with a particulate filter and iodine charcoal cartridge. The accessibility to these features is difficult since personnel must climb up the stack ladder to collect the samples. This would seem to be impractical in case of an emergency where protective clothing and respiratory protection are likely to be required. Further, while the sample flow rate through these sampling features is optimum for low-level release measurement in an emergency situation, this would represent a personnel hazard and could lead to an appreciable source term which may not be measurable by existing sensitive laboratory equipment.

Sampling of noble gases is not provided. Should a puff release occur, emergency procedures would be impaired since there would be no way to identify the isotopic content of the release.

A Priority Level I should be assigned to upgrading of the front end of the radiation monitoring system to assure compliance with current industry monitoring practices and regulations. This is also given a high priority because of the desireability of upgrading the front end at the same time that the WOCC is being upgraded (see Appendix B.3.4.2).

3.4.1.2 Recommended Actions

1. General Recommendations

The system requirements, such as sensitivity range and response time, should be assessed based on the specific operation conditions at ORNL.

This could be developed by reviewing the operating history of the waste contributors to identify their normal operating conditions and analyzing the safety evaluation reports for the major experiments to assess the potential releases as a result of operational transients, such as blackout or relief valve operation, and also following postulated accidents.

The conclusions of this review and analyses should be expressed in terms of monitoring requirements from which equipment specifications would be identified. A review effort such as this is expected to require 12 months and 2,000 engineering manhours to complete.

The cost and schedule of equipment replacement cannot be addressed with any level of accuracy at this time. However, for the purpose of estimating the future budget and effort required, the following should be taken into consideration:

a. The present monitoring system consists of approximately 34 liquid radiation monitors and 15 airborne radiation monitors. Replacement of this quantity of monitors (detectors, shielding, microprocessors, and sampling equipment) is estimated at $750,000.

b. The future improvements will result in an increase in airborne monitors and sampling features (gaseous and liquid). It is estimated that the expenditure for this new equipment could be as much as $500,000.

c. The delivery schedule for this type of equipment is expected to range from 12 to 18 months.

d. Installation and testing of the equipment in a manner that will minimize the impact on operation of the laboratory will take 6 to 9 months to complete.

2. Detailed Recommendations

a. Alpha-in-Water Monitors

The sensitivity of the alpha-in-water monitors could be improved by decreasing the potential for contamination. This can be achieved by modifying the monitor in such a way that the sample water is not in contact with the mylar film of the detector. This could be accomplished by changing the design of the edges of the inlet sample cup in order to obtain an overflow on the side of the cup, resulting in a constant water level in front of the mylar film, but not in contact with the mylar film. This approach allows the use of thinner mylar film, thus reducing absorption and improving the sensitivity.

Another method of increasing sensitivity of the alpha-in-water monitor would be to improve the light pipe of the zinc sulfide detector or to utilize multiple photomultipliers to better match the 15.25 cm diameter of the Lucite light pipe and the 5 cm diameter of the PM tube presently used. (Chiles 1974 indicates that 7 cm off the center of the detector, the response is approximately five times less than at the center of the detector.) The determination method used to derive this attenuation factor does not take into account the absorption of the alpha-in-water which is expected to further degrade the response of the detector because of reduced pulse height.

An R&D program addressing the potential modifications to the alpha-in-water monitor should be developed by ORNL, since no alpha-in-water monitor is available commercially.

b. Beta/Gamma-in-Water Monitors

This sensitivity of the beta-gamma monitors also requires improvement. This can be achieved by reducing the contamination of the monitors as well as increasing the volume of the sample seen by detectors. Reducing the contamination would be done by a change in the basic design of the monitor, since the process water flows upward around the detector, overflows the sample cup and falls down in the polyethylene bottle. The amount of surface in contact with the process water is rather large resulting in an increase in potential for contamination. Using a single sample cup with a process inlet at the bottom and process outlet at the top would reduce the contamination drastically.

Commercial nuclear industry practice to reduce contamination is to automatically or semiautomatically back flush samplers immediately after a release. This has been found to be most effective in reducing the buildup of contamination. Also, welded parts are exclusively made of stainless steel as a method for reducing contamination.

GM tubes are utilized in ORNL's beta/gamma-in-water monitors. This practice has been discontinued in the commercial sector which now utilizes scintillator detectors which allow better dynamic range and sensitivity.

To redesign the present monitors to provide performances equivalent to some commercially available units would involve considerable effort and expense. Therefore, for reasons of schedule flexibility and cost, commercial equipment should be specified, taking system requirements into consideration.

c. Liquid Sampling

Manual sampling of effluent releases is provided as a compliment to the continuous monitoring system; however, it must be relied upon more when the continuous monitoring is not adequate or fails. Considering the difficulties in obtaining adequate sensitivity with continuous alpha-in-water monitoring devices, the frequency of taking grab samples for manual alpha measurements should be increased until a better continuous monitoring device is installed.

d. Alpha-in-Air Monitors

The sensitivity of alpha-in-air monitors is limited primarily by the amount of radon-thoron in air. Several techniques have been developed in the past, such as: a) pulse height analaysis; b) alpha-beta ratio or alpha-beta coincidence; and c) delayed alpha measurement.

The sensitivity of these techniques could be improved. Replacement of the existing monitors using more accurate, commercially available monitors should be considered. Alternatively, ORNL's current R&D program to develop an alpha-in-air monitor using the alpha-beta ratio technique should be made a high priority task. Consideration should be given to the use of fixed-filter monitors instead of the present step-advance system. Fixed-filter systems typically utilize a 5 cm diameter filter which is periodically removed from the sampler. Contrary to the step-advance filter system, which imposes mechanical stress requirements on the filter, the fixed-filter system allows the utilization of a membrane or millipore filter, thereby reducing absorption of alpha in the filter medium. The fact that the fixed-filter is periodically removed provides the basis for laboratory analysis and cross checking of monitor response. The monitor should be located at the base of the stack for easy access. Consideration should also be given to rate-of-rise alarm which, with the utilization of modern digital electronics, has become a reliable feature.

e. Beta/Gamma-in-Air Monitors

The sensitivity of the beta-gamma monitor is limited primarily by the relatively high background count rate, which is a problem affecting most monitors using a step-advance or continuous-feed filter mechanism, primarily because of the difficulties of shielding against ambient gamma radiation.

Most of the beta/gamma-in-air monitors of the commercial type are of the fixed-filter type. Typically, a 5 cm diameter filter is used in this type of monitor, resulting in a sampler geometry which allows good 4π shielding.

The present monitors would require a tremendous amount of redesign to provide performances equivalent to commercial units. Therefore, for schedule flexibility and cost, commercial equipment should be specified, taking into consideration the system requirements.

Similar to the alpha-in-air monitor, consideration should be given to locating the monitor at the base of the stack and to providing rate-of-rise alarm.

f. Iodine-in-Air Monitors

Commercially available iodine monitors are designed in a manner very similar to the fixed-filter beta/gamma monitor, except that a combination fixed-filter and charcoal cartridge is used. Utilization of NaI crystal detectors allows pulse height analysis of the iodine 0.364 MeV peak, resulting in a good discrimination against background and therefore improving sensitivity. Pulse height analysis also provides a large degree of discriminiation against noble gas in the event of a large release. The sampling configuration also allows the utilization of silver zeolite cartridges.

All components required for the construction of the sampling features are commercially available; therefore, it is recommended that sampling equipment be specified using the system requirements as a basis.

Consideration should be given to locating the monitor at the base of the stack and to alarm on rate of rise.

g. Gaseous Sampling

Sampling features should be provided with good accessibility to allow retrieval of the samples in a post-accident situation. These sampling features should be located at the base of the stack and each of the contributing ducts should be sampled to provide for a representative sample.

Iodine sampling should utilize silver zeolite as sampling medium to reduce the amount of noble gases trapped in the cartridge. Noble gas sampling should also be provided utilizing sample bomb and solenoid valves actuated on a high radiation signal from the existing noble gas monitor.

3.4.2 Interface with Data Acquisition System

3.4.2.1 Discussion

The electronic equipment which processes the signals from the radiation detectors associated with the front-end of the radiation monitoring system is being replaced by a modern digital data acquisition system (DAS). The changes expected in the front-end of the monitoring system will be, in part, limited by the capability of expansion of the DAS; also data is presently being shared between the WOCC, the laboratory emergency response center, and the emergency response center, for which the utilization of digital DAS's are being contemplated or designed. Communication between those digital DAS's must be coordinated since they share some of the same inputs.

The expansion capabilities of the WOCC's DAS could limit the upgrade of the front-end of the radiation monitoring system. The following are some of the major areas of expected changes in the front-end of the system which would impact the digital system:

1. Detection Sensitivity

   Efforts to improve the detection sensitivity of radiation monitors usually result in the need to process the detector signals at a low count rate. This requires that the detector pulses be accumulated for a period of time long enough to obtain adequate counting statistics.

   The front-end of the DAS will consist of data concentrators with microprocessors for interface with the detectors. This interface must be carefully specified to allow for improved detection sensitivity and adequate interrogation by the data concentrator.

2. Measuring Range

   Upgrade of the detectors will undoubtedly result in the requirement for a wider dynamic measuring range. A typical NaI detector can provide a measuring range covering up to five decades. To provide for appropriate statistics at the low-end of the range and adequate response time at the high-end of the range requires a sliding time base controlled by the rate of the pulses from the detectors. This sliding time base will probably be part of the microprocessor interface; however, it may also affect communication and interrogation by the data concentrator.

3. Controls

Local control devices, such as flushing solenoid valves, check sources and sampling pump controls must be controlled either automatically or manually from the control room. Requirements such as voltage and power must be addressed.

Since a program is currently underway to expand the DAS, this item should be given a Priority Level I ranking.

3.4.2.2 Recommended Actions

Ideally, before any improvements are decided upon in this case, the study of the upgrade of the front-end discussed in Appendix B.3.4.1 should be completed. However, an alternate approach could consist of characterizing, in a general way, the expected changes in the front-end and including these in the specification for the DAS. This latter approach could be made consistent with the preparation schedule of the specification for the DAS.

3.4.2.3 Follow-on Activities

While this report was being written, ORNL elected to proceed with the alternate approach described above under "Recommended Actions." The following is a summary of the major changes to the DAS specification that resulted from this review:

1. The modification to the front-end of the radiation monitoring system will have minimal effect on the data acquisition system, provided that each monitor has a microprocessor interface location between the detector and the data concentrators.

2. Ample spare room has been made available either in the data concentrator or a separate cabinet provided for the additional microprocessor cards expected as per #1 above.

3. A redundant data highway loop system has been specified for the DAS to satisfy the needs for: a) the transmission of data; b) future system expansion; and c) back-up monitoring function located remotely from the WOCC in the event of an accident.

3.4.3 Release Report Generation

3.4.3.1 Discussion

Liquid and gaseous releases to the environment occur via many different paths. Monitoring requirements result in the need to sample every release point on a regular interval and to analyze the sample for isotopic content. Release reporting requirements are becoming more stringent in that the level of detail and frequency of analysis have increased. Nuclear Regulatory Guide (RG) 1.21 defines the format and the details of the radioactive release reporting requirements applicable to the commercial nuclear industry. It is perceived that the reporting requirements presently imposed on the laboratory will evolve towards a RG 1.21 format, resulting in an appreciable increase in manpower requirements.

Consideration of improvements in this area is perceived to be a Priority Level III item.

3.4.3.2 Recommended Actions

To minimize manpower needs and improve efficiency, the commercial nuclear industry has taken advantage of the capability of computers to generate and update release reports. This is a feature inherent to computer-based radiation monitoring systems. This solution could be readily adapted to the Laboratory since the radiation monitoring system is being changed to a computer-based system and because the grab sample radiation measuring equipment used to compliment the data generated by online monitors is also a digital system.

Computer system hardware and software are available commercially to implement this improvement. To identify the hardware needed, the present equipment capabilities would have to be reviewed. This review would require approximately nine months and 1000 engineering manhours to complete. Estimates of the type, quantity and cost of necessary computer hardware could not be made until completion of this review.

3.4.4 Miscellaneous Off-Gas Release Points

3.4.4.1 Discussion

The major portion of all gaseous radioactive waste is collected by the main off-gas and cell ventilation system for sampling, monitoring and discharge via one of the five large off-gas stacks. Although the gases discharged through this system account for most of the airborne activity released from the site, there are numerous (though much less significant) contributions from isolated release points on the site. In most of these cases, the gases are not routed to the main off-gas system because of physical separation and the impracticality of centralized collection. Provisions are usually available for sampling, and in some cases, for filtering these localized releases.

Several of these miscellaneous gaseous release points are reported in the monthly Radioactive Waste Disposal Operations and Effluent Monitoring Report, but others are not. This in itself is not in violation of regulations, since Chapter 0513 of the DOE Manual states that "individual effluent points representing less than one percent of the total site discharges of the same general type may be omitted" from effluent reports. However, the Manual goes on to state that "the sum of the quantities not reported should not exceed five percent of the total site discharges of the same general type." The concern here is that there appears to be no documented evidence to verify that this five percent limit is not exceeded.

Insufficient data were available to determine whether this is simply a reporting deficiency or whether there is a lack of proper monitoring of these release points. Although there was insufficient time and information available to identify all such release points, at least the following ones were noted:

1. Twelve of the 19 ILW collection tanks in Bethel Valley
2. Three of the four ILW collection tanks in Melton Valley
3. Eight storage tanks in new hydrofracture facility
4. Solid waste compaction facility

In addition to these equipment release points, there are numerous open waste basins and sludge settling ponds that have the potential for airborne releases, either by evaporation or interaction between air currents and dry surfaces along the basin perimeters. Discussions with ORNL personnel, indicate that there may be many unmonitored release points on site. Many of these handle little or no radioactivity and those that do are vented to the plant stack system.

At this time, it does not appear that this situation is of serious concern. Since the total reported site releases are well below allowable limits, the unreported releases would not represent a significant health hazard even if they were to approach the reported releases in total magnitude. On this basis, a Priority Level III has been assigned to this item.

3.4.4.2 Recommended Actions

1. In order to establish a data base upon which to justify exclusion of local release points from monthly effluent release reports, a program should be established to periodically monitor and record the releases from all these points. As a first step in this program, a comprehensive site survey must be conducted to identify all local release points. A procedure should also be written to ensure that once this listing has been developed, it will be automatically updated when changes are made to facilities and/or operation of the laboratory. The frequency with which each release point is to be monitored should be clearly defined and a positive means employed to ensure that this schedule is complied with. For a specific release point, the monitoring frequency will vary, based on the significance of the activity

measured during the initial survey and an understanding of how the system associated with this release point operates under normal or upset conditions.

Establishment of data banks for activity releases from open ponds and basins must be handled differently than those for process equipment. Monitoring of these releases would be difficult to do. Therefore, for these situations, the releases should be analytically determined, using mathematical models of the release mechanisms. In order to perform these calculations, samples must first be taken to determine the isotopic content of each such basin or pond. Assuming that the activity in each pond remains somewhat constant, it would not be necessary to perform this release calculation more than once for each pond or basin.

The initial results of the monitoring program and analytical computations should be kept on file for reference in monthly release reports. It is recommended that this data be made a part of the Safety Analysis Report for the Hot Off-Gas and Cell Ventilation System.

It is estimated that the initial site survey, collection of samples, and analysis work would take three months and 2,000 man hours to complete. Manpower requirements for periodic follow-on monitoring would be dependent on the results of this initial work but are expected to be minimal.

2. If the results of the initial survey indicate that a significant portion of the site releases are not being continuously monitored, it may be desirable to add continuous monitors for the more important release points. Whether or not continuous monitors with telemetered readout in the WOCC are needed would be dependent on the circumstances surrounding each source and cannot be speculated on at this time. The estimated cost of state-of-the-art airborne activity monitors such as those described in Appendix B.3.4.1 is $25,000 per monitor, including installation and remote readout at the WOCC. Estimated procurement and installation schedule is 18 to 27 months.

3.5 GENERAL WASTE MANAGEMENT

3.5.1 Facilities Consolidation

3.5.1.1 Discussion

When ORNL was created in 1943, facilities for collection, processing and disposal of radioactive waste were planned and constructed in a relatively short period of time in order to support the war effort effectively. At that time, there was little consideration of the future R & D work the laboratory would eventually become involved in. As the laboratory expanded, the original radwaste systems also expanded to handle the increased demands this additional R & D work placed on them. However, because the radwaste systems were not originally planned with such expansion in mind, the systems, as they exist today, are not as efficient in design and layout as might otherwise be possible. The systems extend over a large area, requiring transportation of solid, liquid and gaseous wastes long distances under conditions that are at times more difficult and hazardous than necessary. For instance, both liquid LLW and ILW are collected in Bethel Valley in a dilute aqueous form that is relatively easy to pump and safe to handle because of the low specific activity. Rather than pumping the waste in this form to Melton Valley for concentration and ultimate disposal, it is first concentrated in Bethel Valley and then pumped a half mile to the disposal area. By concentrating the waste before transport, both the difficulty and safety associated with this task are increased. Furthermore, transferring solutions with high solids concentrations long distances either requires some dilution of the waste concentrates produced by the LLW and ILW processing systems, or limits the degree to which these waste can be concentrated. In either case, this results in lower net volume reduction prior to disposal and equivalent increases in disposal costs and land usage.

The large system of tanks and piping that makes up the ILW collection system is another example of unnecessary complexity and inefficiency. Although the evolutionary process for the ILW collection system is not entirely clear, there are many cases where buried collection lines from adjacent buildings travel many hundreds of meters side-by-side to intermediate collection tanks that are also adjacent to each other. From there, transfer lines from each tank again travel side-by-side, eventually ending in the same central collection tank. In each case, no differences occur in the way the wastes are treated, and no special control or sampling is required, thus negating any obvious reason there might be for the added cost this duplication creates in terms of initial capital investments, operating and maintenance costs, personnel exposures, increased risk of environmental contamination, and future D&D costs.

Undoubtedly, the evolution of these inefficient operations has been heavily influenced by the functional requirements and regulatory conditions in existence at the time the systems were installed or modified. Regardless of the reasoning, continuation of a planning practice that only considers immediate, short-term needs in modifying or expanding the radwaste systems will result in a continuation of the type of situations described above.

The concerns presented here are related to long term planning and systems operation rather than to immediate safety or environmental concern. Therefore, this problem area is classified as Priority Level III.

3.5.1.2 Recommended Actions

The planning of all future radwaste system modifications and additions should be directed towards a common goal of consolidation and simplification of these systems wherever and whenever possible. This should be a stated objective of ORNL'S formal radwaste improvements program plan for the next 20 years, as discussed in section 1.2. In support of this policy, a report should be generated outlining the areas in which such consolidation is feasible. As a criteria document, this report would serve as a tool to ensure continuation of this policy of consolidation as system modifications and additions are designed and brought into being over the next 20 years. This document should also be viewed as a flexible one, since policy towards consolidation may need to change as regulatory and operational conditions change over the course of time. Therefore a mechanism should be established for periodically updating this document so that it will be of continued use as a design criteria document.

For the areas in which consolidation is recommended, the report should identify the impact consolidation would have on the cost and schedule of individual improvement projects and the benefits to be gained from consolidation in each case. Where the report indicates that consolidation is justified, the reasons for requiring consolidation must be clearly stated for future reference.

As a minimum, the following areas of consolidation should be pursued in this study:

- Eliminate all intermediate holdup tanks between the source generator buildings and evaporator feed tanks in the ILW collection system. This is discussed in greater detail in Appendix B.3.2.6.

- Eliminate LLW and ILW collection and processing systems in favor of a combined system for handling both types of waste without segregation. This is discussed in more detail in Appendix B.3.2.6.

- Consolidate the present waste evaporation process and any future volume reduction capabilities in a complex adjacent to the new hydrofracture facility. This consolidation would serve a number of useful purposes discussed in greater depth elsewhere in this report and summarized briefly below:

  a. Location of future VR systems next to the hydrofracture facility is justified on the basis of the resultant simplification and cost savings for interfacing with the hydrofracture facility.

  b. Relocation of the evaporator facilities adjacent to the hydrofracture facility can be justified for several reasons. First of all, this would eliminate the problems associated with transferring evaporator concentrates long distances. Secondly, if liquid wastes are to be handled by future VR systems, preconcentration by evaporation may be necessary, depending on the type of VR system selected. Added evaporation capacity may also be needed to handle the type and quantity of decontamination solutions expected from future D&D projects and to handle increased system loads if the LLW and ILW systems are combined, as suggested in Item 2 above.

- Consolidate plans to replace or upgrade the collection systems for gaseous radwaste and liquid LLW and ILW. As discussed in other sections, all three of these systems are in various stages of disrepair. Replacement of the ILW collection system has already been determined to be necessary, and there appears to be ample justification for replacement of the other two systems. Since all three systems service the same basic areas of the laboratory, it appears that there would be considerable cost benefit (in terms of excavation costs, schedule reductions, etc.) to a well coordinated effort to replace all three systems simultaneously, possibly employing a concept of using one central concrete vault system for containment of all three of the new systems.

  The schedule for completion of this report would be dependent on completion of several data gathering and inspection programs that would have an impact on consolidation planning. These are covered in Appendix B.3.1.1, B.3.2.1, B.3.2.2, B.3.2.5, B.3.2.6, B.3.2.7, B.3.3.1 and B.3.5.2. Once all input is available from these other tasks, it is estimated that the initial consolidation planning report could be completed in three to six months. Approximately 2000 manhours would be required for this task.

3.5.2 Interface With Future D&D Projects

3.5.2.1 Discussion

As part of DOE's plan for decommissioning contaminated surplus facilities (Carroll 1979), seven major D&D projects have been identified at ORNL. The major facilities involved in each of these projects are listed in Table A.1-14, together with estimated quantities of waste generated as a result of these projects. As this table illustrates, decontamination and decommissioning of these facilities will be a major undertaking that will have a significant impact on radioactive waste management operations. The solid waste produced by these projects will create major packaging, handling and disposal difficulties because of the quantities (and in some cases the activities) involved. For some of this work, entombment is specified as the decommissioning method. Should entombment not be acceptable for technical or regulatory reasons, the additional quantities of SRW that this would create would magnify these problems significantly.

Current predictions of the quantities of HLW and TRU contaminated waste generated by these projects suggest that the present storage system can adequately handle this additional waste. However, if these predictions are found to be too low, the lack of volume reduction capability for portions of these wastes could result in further handling and storage difficulties.

Each D&D project can be expected to generate varying amounts of highly radioactive sludge. Depending on the level to which each facility must be decontaminated before disposal or entombment, large amounts of decontamination waste solutions may also be generated. Depending on where the surplus facility is located, transfer of these wastes to the ILW system could be a difficult materials handling task, with the potential for significant man-rem and dollar expenditures. The ability of the ILW processing equipment to handle these wastes is also of concern. The compatibility of the sludges with the hydrofracture facility is unknown, and the presence of chelating agents in these wastes may place limitations on how these liquids may be disposed of. The chemical composition of some of these decontamination solutions could also cause foaming, scaling and corrosion in the ILW evaporators. Furthermore, if significant quantities of decontamination liquids are generated, the capacity of the ILW evaporators to process them in a satisfactory time frame may be exceeded.

To some degree, all of the proposed D&D projects will involve such activities as equipment dismantlement, exhumation of buried components, removal of structures, and the decontamination of various surfaces prior to entombment. In addition to the impact these activities will have on the solid/liquid/gaseous waste handling systems, they will also have an impact on the environment. Excavation and demolition work may create airborne contamination hazards; and groundwater contamination may result from decontamination activities or contact between the contaminated facilities being dismantled and rainfall or surface runoff.

As discussed above, planned D&D projects at ORNL need to be closely looked at from the standpoint of worker safety, impact on the environment, radwaste system processing capabilities, and waste management economics. For these reasons, this problem area has been assigned a Priority Level I.

3.5.2.2 Recommended Actions

1. Published data on the quantities, activity levels, and chemical/ physical characteristics of the wastes generated by these D&D projects are preliminary estimates. In order to develop realistic plans for handling these wastes, more detailed information should be gathered. It is recommended that a comprehensive data acquisition program be set up for this purpose. This would involve extensive field work to gather sample data, conduct radiological surveys, measure quantities of sludge, catalog/categorize components and structures, etc. This program would also involve an exhaustive search for and review of all design documentation pertaining to each facility in all of the proposed D&D projects.

   In acquiring this data, it should not be presupposed that a facility will be entombed in place. Based on the geological/hydrological conditions existing at ORNL, this may not be a satisfactory disposition for many of the facilities.

   For each facility, enough data should be gathered to determine the extent and type of decontamination required to reduce contamination levels below the limits for unrestricted reuse, as set forth in ANSI N13.12 (ANSI 1978). Sample measurements of the effectiveness of various decontamination methods may be necessary to make this determination.

   The data acquisition program outlined here is expected to require considerable time, manpower and expense. The level of effort will vary, depending on the complexity of each D&D project. For conservatism, it is estimated that at least one month and 800 manhours will be required to gather the necessary data for each project. The entire data acquisition program for the seven D&D projects in question is estimated to take nine months and 6000 manhours to complete.

2. It is recognized that under the project organization for these D&D projects, it is unlikely that the waste management operations group will be given unilateral responsibility for making many of the planning decisions that will directly or indirectly affect the quantity or characteristics of the wastes that this group must be prepared to handle. Decisions on such items as what decontamination technique to use and whether or not entombment is acceptable will quite probably be compromises between the interests of waste management and other departments, divisions, and outside agencies (Health Physics, Environmental, EPA, DOE, etc.). However, the project should be organized to insure that the waste management group will play a major role in making these decisions, either directly, as a member of the committee(s) authorized to develop these plans, or indirectly, through a formal review and approval cycle.

3. Carrying out the many D&D projects at ORNL will involve considerable manpower, occupational exposure, and expense. It is estimated that the seven projects listed in Table A.1-14 will cost $40,000,000 and require 330 man-years of engineering and labor. Before committing such sizeable amounts of capital and labor to these projects, serious efforts should be made to insure that all possible reuse applications have been thoroughly considered for these facilities. As noted in UCC-ND Engineering Procedure EP-C-26, "the availability of suitable sites for expansion and new construction is becoming limited due to growth of ORNL and planning for utilization of these sites must be done to assure optimum usage of available land." Because entombment of a facility results in the effective loss of land areas associated with that facility for other uses for a very long period of time, it is particularly important in these cases that there is complete agreement that no further use can be made of this facility and that the cost to demolish and remove the facility would outweigh the need to make this land area useable for other purposes.

   It is recommended that an inter-division task force be set up to study this matter. Members of the committee should be thoroughly familiar with all current and future (both definitive and speculative) needs of their respective divisions. As a prerequisite to conducting this evaluation, complete information about each surplus facility would be necessary. Therefore, before forming this task force, the data acquisition program recommended in Item 1 should be sufficiently complete to allow a firm decision to be reached on reuse application for each facility.

There are numerous potential reuse applications of these facilities for waste management activities. The following are among those that should be thoroughly evaluated by the task force:

a. Use one or more of the gunite storage tanks in place of the open and unlined Equilization Basin (3524) for collection of LLW. (See Appendix B.3.2.2.)

b. As a backup or replacement for hydrofracturing, modify the grout mixing equipment to permit above-ground waste encapsulation and storage in portable/disposable liners (See Appendix B.3.2.7.)

c. Use one or more of the gunite storage tanks for retrievable storage of drummed TRU waste. After these tanks are decontaminated, a remotely operated crane could be installed as shown in Figure B.3-11 to stack drummed waste within the tank. Each tank modified in this manner could store approximately 14,000 M^3 of waste in 250 liter drums stacked four rows high.

d. Use one or more of the decontaminated gunite tanks for storage of processed waste water that is designated for recycle applications (See Appendix B.3.2.5.)

e. Use one or more of the facilities now on the surplus facilities D&D list to house future VR systems.

f. Use one of the facilities now on the surplus facilities D&D list to house a centralized incineration facility for all UCC-ND hazardous combustible waste (See Appendix B.3.1.1.)

Completion of this reuse applications study is estimated to require three months and 2500 engineering manhours. This estimate assumes that the study recommended in Item 1 above has been completed first.

4. After all waste quantities and characteristics have been determined as part of the data acquisition program outlined previously, a thorough evaluation is needed of the processing, solidification and storage/disposal requirements for each anticipated waste to determine whether or not the existing system can handle these wastes. This study would identify the need for additional or different types of processing capabilities, the need for additional retrievable waste storage capacity, etc. Where the wastes are found to be incompatible with the present radwaste processing, solidification or disposal techniques, the study should identify the need for R&D work to correct these incompatibilities. For example, there may be restrictions on shallow land burial of wastes containing chelating agents because of the adverse effect these agents have on the capacity the native soils have for retaining radionuclides by ion exchange. In this case, R&D work may be justified to identify substitute decontamination agents that perform as well as the chelating agents without this adverse side effect, or to identify ways of tying up these agents in a manner that will not allow the chelating agents and soil to interact in this manner.

Based on the outcome of this study, further R&D work and/or modifications to the radwaste processing system can be planned, as required, in preparation for the start of these D&D projects. A side benefit of this evaluation and any associated R&D work is that the results can be applied directly to the commercial nuclear power industry, where there is a great need for this type of information because of the ever increasing amount of decontamination work associated with both plant maintenance and plant decommissioning.

A prime example of this is the current gunite tank decontamination project and the possible application of the results of this project to the decontamination of the containment sump at Three Mile Island. After the water in the sump has been drained, it is expected that removal of residual surface contamination and sludge from the bottom and lower walls of this sump will be a difficult task. However, little is known at this time concerning such aspects of this project as what the levels of residual contamination will be, how effective various decontamination techniques will be, how much waste will be generated in the process of performing this decontamination, and how the decontamination wastes will effect the ion exchange columns evaporator currently available at TMI for processing these wastes. Many aspects of these two projects are quite similar; and therefore, data for the gunite tank decontamination project should be invaluable to those engaged in cleanup of TMI.

It is estimated that a complete and thorough evaluation of the interface between the proposed D&D projects and the waste processing/disposal systems, excluding any follow-on R&D work, will take approximately three months and require 1500 engineering manhours. Again, this is dependent on the data acquisition program, outlined previously, having been completed first.

3.5.3 Waste Generator Interface

3.5.3.1 Discussion

Efficient, optimized operation of the radioactive waste processing systems requires detailed knowledge of the chemical and radiological makeup of the waste inputs. Ideally, this information should be known for the individual waste contributor so that some control can be exercised over the type and quantity of waste received.

Liquid wastes are the only form of waste at ORNL that receive any significant process treatment prior to release or disposal. For these wastes, very little information is known about the makeup of the individual waste inputs. The existing collection system design does not readily permit such information to be gathered, and efforts to compensate for this by administrative means would be difficult. Nearly all of the sample data that is available is for diluted waste just prior to processing, at which point the identity of any particular waste input is lost. Recent periods of off-standard operation in the LLW processing system illustrate why this can be a disadvantage. An exhaustive inspection of the system after several of these periods of poor performance (Chilton 1980) was unable to pinpoint the cause for them. Had there been a record of the quantities and characteristics of individual generator inputs available for this investigation, it is possible that a correlation could have been uncovered between a particular source and this problem. Similarly, the cause of occasional periods of foaming (and resultant poor performance) in the ILW evaporator could possibly be traced back to a specific generator.

Ever increasing restrictions on releases to the environment will require improvements in design (additional volume reduction, etc.) and operation of the radwaste processing systems. This in turn will increase the cost of processing and disposal of these wastes dramatically, and in order to recover these costs, it may become necessary to budget for them when funding specific R&D projects. Under the present conditions, it would be difficult to insure that the correct R&D projects are being assessed charges for processing these wastes because of the lack of any monitoring or control capabilities.

The concerns discussed here are not ones that are likely to result in near or long-term safety hazards or environmental damage. Because improvements in this area have the potential for increasing system performance and reducing operating costs, a Priority Level III has been assigned to this area.

3.5.3.2 Recommended Actions

1. As an interim measure, a computer-assisted data collection program should be established for recording and monitoring inputs to the LLW and ILW systems. Because both systems lack installed capabilities for automatically measuring the desired parameters for individual contributors, manual and administrative methods must be used for gathering this data. As the first step in this program, all drain lines should be traced back to their origin, and those individuals using these drains should be interviewed to determine typical frequencies, quantities, and characteristics of all wastes. This data and listing of contributors should be kept on file for use as a benchmark and future reference point.

After analysis of this data, a listing should be made of those generators that contribute more than 1 percent of the total volume or activity to the system, or that put significant quantities of any strong chemicals into the system. For each project in this second listing, an administrative procedure should be established to require that the project submit a periodic tabulation of all wastes sent to the liquid radwaste systems. This tabulation could be daily, weekly or monthly, depending on the nature of the wastes. Additional submissions should be required whenever the generator produces more waste than normally expected. Each report should be submitted on a standard form that is in a format that can be readily put into the computerized data storage/retrieval system.

Once this system has been set up, it should be used regularly to observe operating trend of the processing systems, spot potential problem areas, identify the cause of problems, etc. Significant data obtained from this program should be included in the monthly effluent monitoring report.

It is estimated that to collect the initial data base for establishing a benchmark for future reference and to set up the format and program for the computerized data storage/retrieval system will require six months and 3000 engineering manhours to complete. Manpower requirements for inputing data to the system would be spread over the spectrum of projects interfacing with the radwaste systems and should not be a significant additional work load for most of these individual projects.

2. As a long-term corrective measure in conjunction with the proposed replacement projects for the LLW and ILW collection systems, means should be installed to automatically measure flow rates and obtain manual grab samples of the waste leaving each source generator building. On a case by case basis, additional automatic measurements may be desirable for such parameters as pH, conductivity and radioactivity. If it is determined that source generators within a particular building need to be monitored individually, then the methodology described in Item 1) above would be employed in these situations.

The degree to which the collection system is to be upgraded will determine what type of monitoring can be added. If the LLW and ILW collection systems are combined, as described in Appendix B.3.2.6, with individual sumps being provided in each building, then there would be considerable flexibility to provide whatever degree of monitoring and control capability that is deemed necessary.

If these systems are to remain separate and the ILW drains are to be directed to a centrally located intermediate holdup tank as currently proposed, then fewer individual buildings can be monitored. Conceptual plans for this case already call for flow measurement and grab sample capability for each drain line routed to this central tank. With this concept, the administrative methods described above in Item 1) would have to be used if a more refined degree of monitoring and control over system inputs was desired.

If the LLW and ILW systems are not combined, then the LLW contributors should be monitored as recommended in Appendix B.3.2.1, using a portable weir in the manhole nearest to each source generator building.

Whatever degree of additional monitoring is installed, any automatic readouts should be tied into the WOCC and DAS for efficient collection, readout and analysis. Cost and schedule information for each of the above monitoring schemes are presented in Appendix B.3.2.1 and B.3.2.6.

3.5.4 Design Documentation

3.5.4.1 Discussion

There is a lack of complete and up-to-date design documentation (such as piping and instrumentation drawings (P&ID's), system descriptions, design criteria, etc) for portions of the liquid, solid and gaseous radwaste systems. Design documents and operational records for portions of the systems installed 30 to 40 years ago are minimal, making it difficult to adequately review these systems from both a functional and safety standpoint. Such reviews should be done periodically to insure that the systems will continue to perform their intended functions safely and efficiently in a climate of ever-changing operational conditions and regulatory requirements. In the years since ORNL was established, many additions and modifications to the original systems have been made to satisfy specific, short-term needs. The documentation of these changes has at times been on a piecemeal basis, without consideration of interfacing design documentation or of the need to maintain continuity in the approach to how and what design data is to be recorded.

Conspiciously absent from the existing documentation are system P&ID's that encompass all portions of each system. Only a few P&ID's are available, and these only cover a portion of each system. Of particular concern is the lack of such a document for the collection subsystems. Within source generator buildings, there does not appear to be any information readily available about these collection subsystems, even though the system atlas drawings indicate fairly complex collection and processing capability in some of these structures (such as TURF and the Transuranium Research Laboratory). Similarly, no P&ID is available for the sophisticated network of piping, ductwork, intermediate holdup tanks and transfer jets/pumps that make up the underground portion of the collection subsystems. The atlas drawings give a general idea of what these underground systems consist of, but these drawings are difficult to read and understand and are also incomplete. Only someone who already has a thorough working knowledge of the system could fully understand what is presented on drawings such as this. Furthermore, these drawings give little or no information about instrumentation, how the components are controlled, safety classification, interface with other systems (such as steam for the eductors), component sizes, and equipment identification (e.g., valve numbers). Information such as this is essential to have, and documenting it by means of a P&ID is the normal method used for most process systems. Design control and regulation of the commercial nuclear power industry would not be possible without this basic design document; and indeed, if the NRC were ever to assume a regulatory role at ORNL, the lack of such documents would be unacceptable, since a complete system P&ID is a fundamental requirement for any safety analysis report submitted to the NRC for review.

In addition to basic design information not being readily available, portions of the existing information are inaccurate and/or out of date. For example, the existing atlas drawings were last updated in 1970, and the accuracy of this revision was conditional, as indicated by the following note appearing on these drawings.: "This atlas is complete only insofar as available information permits". Since there is no requirement that documents such as the atlas drawings and system descriptions be updated when new projects are initiated, these changes are not always reflected in such documents. As an example, there is no indication on the current atlas drawings of the fact that a new double-contained collection header is used to bypass the gunite tanks directly to the ILW evaporator. Similarly, these drawings do not show new ILW tanks and transfer lines in Melton Valley.

In addition to the above deficiencies, current storage and retrieval methods for available design information do not permit ready access to some of this data. Table B.3-11, taken from UCC-ND Engineering Procedure EP-A-13, illustrates the fact that filing of much of this information is the responsibility of the individual projects. Once a project is completed, retrieval of this information that is not centrally filed becomes increasingly difficult and uncertain with time. In addition, information that is centrally stored is done so semi-manually, without computer search capability for specific types of information.

There are no safety concerns associated directly with these weaknesses in documentation, nor do they represent any violation of regulations. However, since there are many major radwaste system construction projects being planned for the next five to ten years, it would be appropriate to institute improvements in the documentation generation, storage and retrieval methods at this time. Therefore, this area has been classified as a Priority Level II item.

3.5.4.2 Recommended Actions

1. For each of the radwaste systems, a complete P&ID and detailed system description should be developed. These two documents should be considered the design basis for each system, and as such, procedures should be

instituted to insure that they are complete and accurate, that any future system modifications or additions are incorporated into them, and that their distribution (both original issue and all revisions) is positively controlled to insure that those in possession of these documents are assured of having the most current information. No system changes should be permitted without first revising these documents and completing a review/approval cycle for the revisions.

As the authoritative source of all design basis information for each radwaste system, these documents should be complete. As a minimum, the P&ID should include the following:

a. Pipe size, material, pressure rating

b. Valve/equipment/instrument ID code, compatible with computerized information storage/retrieval system

c. Safety classification boundaries

d. Design and operating pressure, flow, temperature conditions

e. All local/remote instrumentation

f. Basic control logics for all active components

g. Interface with other systems

h. Basic component data (pumping capacities, tank capacities, etc.)

The system description should supplement the P&ID, providing information that is not possible to put on the P&ID. Reference may be made to other controlled documents, such as component specifications, physical drawings, manufacturers drawings and data, detailed operating instructions and operating records. The system description should include the following:

a. System functions

b. Design criteria

c. Summary and detailed description of system components and modes of operation

d. Hazards and safety precautions

e. Maintenance/Testing requirements

Development of a complete design documentation package as described above would be a major undertaking. It would be particularly difficult and time consuming to gather the necessary design information about collection and processing subsystems within the various source generator facilities. Nevertheless, every effort should be made to obtain this information for completeness, so that in the future, workers involved in reviewing, operating, maintaining, modifying and dismantling these facilities can be assured of having a true and accurate picture of the overall system. Some time could be saved by excluding from these documents those facilities that are not in use and are scheduled for dismantlement as part of DOE's surplus facilities program. However, mothballed facilities that may one day be used again (TURF, for example) should be covered in detail.

Field measurements and verification will be necessary in many areas when assembling these documents, lengthening the project duration and increasing manpower requirements considerably over what would normally be required to develop a P&ID and system description. However, some time and cost can be saved if these documents are upgraded at the same time that proposed projects for upgrading the LLW/ILW/GRW collection systems are carried out. On this basis, the estimated effort for completion of this work is 6000 manhours.

The recommendations made here concerning the P&ID and system description also apply to all other controlled documents that contain design information that must be kept on file for historical purposes, use in future planning, future system reviews and audits, etc. These documents should be brought up to the current, as built condition of the facility, and should be kept current as future plant modifications are made. The cost and manpower commitments for doing this should be included in the budget for each new project that affects these documents.

2. It is recommended that a computerized component numbering system be set up for uniquely identifying all system components and structures and for allowing computerized storage/retrieval of listings of pertinent design documents. Each item in the system would be identified by a unique number that appears on a computer printout along with a description of the item and reference information, including identification of documents that provide detailed information about the item. A typical equipment list for a radwaste system is shown in Table B.3-12. Development of a typical numbering scheme is described below.

   Each item in the equipment list is given a nine digit identification number which is divided into three parts. The first three digits consist of a letter followed by two numerals and is known as the "system-designation". Any arbitrary combination, such as "G50", could be used to stand for any system, such as the liquid radwaste system, gaseous radwaste system, etc. This three digit prefix is also used to identify the system description for the particular system.

   The second part consists of a single letter which identifies the type of equipment. A few typical code letters are listed below:

   A - tanks
   C - pumps, fans, blowers, compressors, etc.
   F - valves and valve operators
   S - electrical equipment
   R - recorders, controllers, indicators

   The third part of the code is a five digit serial number, consisting of four numerals followed by a single letter to identify multiple duplicates of equipment.

A typical equipment number for a redundant radwaste system pump would be G50-C0001A. This number would appear alongside the item wherever it is shown on design documents such as P&ID's, physical piping drawings, and vendor drawings. It would also be given in the system description, equipment specification, vendor data sheets, etc.

When logging all design documents into the computer, this equipment number would be used to match a document with an equipment item. For instance, if the P&ID showed a tank numbered G50-A0004, the computer could be asked to print out the number of the specification used to purchase this tank, the numbers of all physical drawings on which the tank appears, and a listing of all vendor drawings for this item. In this manner, all available design documentation for a particular equipment item can be called up, allowing quick retrieval and insuring that all pertinent design documents have been considered.

The engineering time required to institute this numbering scheme for all of the radwaste systems, including renumbering of design documents and inputing to the computer program, is estimated to be 4000 manhours. Some portions of this new system could be instituted at the same time that related radwaste system replacement projects are started to reduce the overall cost and schedule impact.

3. To insure against loss of important design documents and operating records as a result of natural disasters and fires (such as the one that destroyed a portion of the records of the waste contained in SWSA's 4 and 5), a dual record keeping system should be instituted for storing record copies of these documents in separate, centralized locations having adequate means of preventing damage from fire, water, aging, etc. It is recommended that all of these records be stored in the form of microfilm or computer tapes (where appropriate) in order to satisfy the safe storage requirements in the best possible fashion. This form of storage would also be more compatible with the computerized storage/retrieval system recommended in Item 2 above than if the stored documents were in hard-copy form.

It is difficult to assess the cost of this project without complete knowledge of the amount of design documentation and operating records now on hand in various locations and the form that the documentation is in. It is estimated that three months and 1,000 manhours would be needed to thoroughly evaluate the present system. Current costs for microfiling a single document are about 45¢/sheet for the first copy and 12¢/sheet for additional copies. These costs include the fees for mounting on computer cards and keypunching identification codes. For radwaste system modification and improvement projects now in progress or being planned, the initial cost of this method of records keeping would be competitive with, and may even be less than, the cost of maintaining a file of hard copies for the many documents involved.

3.5.5 ALARA Program

3.5.5.1 Discussion

ORNL was established long before the term ALARA was introduced, but never-the-less, ORNL has always recognized the need to keep exposures to workers and the general public below established limits and as low as possible where practical to do so from a technical and economic point of view. A similar policy has also been followed with regard to discharges to the environment.

Since the introduction of the term "ALARA" (and its predecessor "ALAP"), there has been ever increasing pressure to reduce exposures and releases further and further, sometimes to levels that some experts would consider as unjustifiably and unreasonably low. But because there is no fixed value attached to this term, there will continue to be some controversy regarding its application to a particular facility design or operation.

For several reasons, closer attention must be given to complying with ALARA criteria at ORNL than might be expected at some other installations. These include:

- The large volumes of waste handled. Over the past years, ORNL has processed an average of 3,000 M^3 of solid waste and 2.4×10^8 liters of liquid waste. In comparison, a 1000 Mw PWR station normally generates 500 M^3 of solid waste and 8×10^6 liters of liquid waste. Furthermore, since the waste produced at ORNL is also disposed of there, more time is spent handling the waste than would be the case at a facility that is only involved in the generation, processing and packaging of the waste.

- The high activity level of some of the waste streams handled. The normal activity level in the ILW system is 10 μCi/cc, but the system is designed to handle waste as high as 5.3×10^3 μCi/cc. The LLW system normally processes waste containing an average of $<10^{-5}$ μCi/cc. In comparison, the liquid waste produced in a PWR normally ranges from 5×10^{-5} μCi/cc for secondary side drains to 3×10^{-1} μCi/cc for primary side drains.

- Physical separation of facilities. Because the laboratory is spread over a large area, some wastes must be transported distances of a mile or more for processing and disposal. This separation creates additional opportunities for exposure to operators, maintenance personnel, other laboratory employees, and visitors.

- The deteriorating condition of some portions of the radwaste systems. Because of this condition, there will be an increased need for maintenance, repair and replacement, resulting in additional exposure to maintenance personnel.

- Increased emphasis on non-nuclear R&D. In recent years, less of the Laboratory's research work has been associated with nuclear energy than in the past. This trend is expected to continue, increasing the number of workers and visitors that have little knowledge of or working experience with radioactive material. These people should be considered part of the general public rather than nuclear industry workers, and, as such their allowable exposure levels would be those of the general public. Potential situations in which these persons could become contaminated or exposure to excessive radiation under normal or accident conditions may not be considered ALARA situations.

- Advent of surplus facilities R&D. At least seven major D&D projects are planned for surplus facilities at ORNL. Large amounts of radioactive waste will be produced as a result. In turn, there will be increased chances for worker exposure and environmental contamination.

The need for improvement in this area is considered a Priority Level III item.

3.5.5.2 Recommended Actions

1. Establish an independent ALARA review board to review and approve all future projects strictly from the standpoint of their compliance with ALARA. This committee would be composed of inter-divisional personnel with background knowledge and/or experience in health physics, radwaste system design, and regulations on exposures and activity discharges. This committee should be independent of the project or operation being reviewed, reporting through a different chain of command to an individual above the project management team. By assigning the ALARA review function to one specific group for all projects, greater assurance is given that each project will be adequately reviewed. This will also insure a more consistent approach to ALARA for the entire laboratory.

2. Periodically, the radwaste management operations should be reviewed to insure that ALARA criteria are being complied with. To do this in the most efficient and thorough manner possible, a computerized system should be developed to correlate personnel exposures to specific work tasks. This would require development of an RWP format that permits the work descriptions to be readily inputted into the computer. The use of very specific work descriptions should be encouraged to aid in making a meaningful correlation between the individual's exposure and his work activity.

   While conducting this study, it was learned that the health physics organization at ORNL is currently developing an exposure tracking system that will perform the functions described above. The waste management operations group should work closely with the health physics organization to insure that this system will satisfy their needs.

TABLE B.3-1

SUMMARY COST COMPARISON OF ALTERNATIVE LLW COLLECTION SYSTEM CORRECTIVE ACTIONS

Alternative Method	Total Cost*
Grouting	$ 150,000
Lining - Slip Line	$ 750,000
Lining - Membrane	$1,600,000
Replacement	$1,200,000

* Costs are for all lines 15.25 cm in diameter and larger.

TABLE B.3-2

COST AND SCHEDULE COMPARISON OF
ALTERNATIVES TO OPEN LLW COLLECTION BASINS

	Alternative	Cost	Schedule
1.	Line and Cover Pond 3524	$305,000.00	8-10 Months
2.	Cover Ponds 3539 and 3540	$ 44,200.00	4-6 Months
3.	Line Gunite Tanks for use in Lieu of Pond 3524	$300,000.00	12-18 Months

TABLE B.3-3

SUMMARY COST COMPARISON OF
LLW SLUDGE PROCESSING ALTERNATIVES

Alternative	Capital Cost	Annual Operating Cost
a. Dispose of sludge via hydrofracture:		
1. Without dewatering	N/A	$75,000
2. After dewatering	$100,000	$ 7,500
b. Dewater and package:		
1. Shallow land/burial	$100,000	$ 3,000
2. Above ground storage	$100,000	$ 4,500
c. Solidification:		
1. Cement/modify hydrofracture equipment:		
i. Shallow land burial	$250,000	$13,000
ii. Above ground storage	$250,000	$16,000
2. Polymer/mobile equipment:		
i. Shallow land burial	$750,000	$15,000
ii. Above ground storage	$750,000	$14,000

TABLE B.3-4

WATER USAGE FOR GROSS MANUAL SURFACE DECONTAMINATION TO < 100,000 dpm/100 cm^2

Surface	Method	Vol/Area
Painted concrete floors	High Pressure (HP) water	1.5 l/m^2
	Low Pressure (LP) water	1.0 l/m^2
Unpainted concrete floors	HP water	1.5 l/m^2
	LP water	1.0 l/m^2
Stainless steel wall liner	LP water	1.0 l/m^2
Walls and overheads (painted and unpainted)	HP water	1.5 l/m^2
Concrete block	HP water	1.5 l/m^2
Painted and SS grating or deck	HP water	1.5 l/m^2
Structural steel	Wet/Dry (W/D) vacuum	6 $m^3/100\ m^2$
	HP water	1.5 l/m^2
Piping (external)	W/D vacuum	6 m^3/m^2
	HP water	1.5 l/m^2
Mirror insulation	LP water	1.0 l/m^2
	W/D vacuuming	6 $m^3/100\ m^2$
Painted cable tray	W/D vacuuming	6 $m^3/100\ m^2$
	HP water	1.5 l/m^2
Electrical cable	W/D vacuuming	6 m^3/m^2
	LP water	1.0 l/m^2
Ductwork [illegible])	W/D vacuum	6 $m^3/100\ m^2$
Painted mechanical equipment	W/D vacuum	6 $m^3/100\ m^2$
	HP water	1.5 l/m^2

Notes:

1. High velocity water ranges from 70 Kg/cm^2 to 700 Kg/cm^2.
2. Low velocity water is < 35 Kg/cm^2.

TABLE B.3-5

WATER USAGE FOR HANDS-ON
DECONTAMINATION TO < 10,000 dpm/100 cm^2

Surface	Method	Vol/Area
Painted concrete floors	High Pressure (HP) water	1.5 l/m^2
Walls and overheads (painted)	HP water	1.5 l/m^2
Painted/SS decking	HP water	1.5 l/m^2
Structural steel	HP water	1.5 l/m^2
Piping	HP water	1.5 l/m^2
Mechanical equipment	HP water	1.5 l/m^2
Painted concrete block	HP water	1.5 l/m^2

Note:

1. High pressure water ranges from 70 Kg/cm^2 to 700 Kg/cm^2.

TABLE B.3-6 -- AVERAGE LOSS OF WEIGHT AND MAXIMUM PENETRATION OF HIGH-ALLOY STEEL SHEETS EXPOSED FOR 9 YEARS.

M, shallow metal attack, roughening of surface, but no definite pitting.
P, definite pitting, but no pits greater than 6 mils.
U, apparently unaffected by corrosion.
+, one or more specimens contained holes because of corrosion, rendering the computation of the exact penetration impossible. The thickness of the specimen has been used as the maximum pit in this case.

Soil No.	(5)[a] 11.95% Cr 0.18% Ni .38% Mn — Loss, average	Maximum penetration, average	(5) 17.08% Cr 0.09% Ni .30% Mn — Loss, average	Maximum penetration, average	(2) 17.72% Cr 0.44% Mn — Loss, average	Maximum penetration, average	(1) 17.76% Cr 3.83% Ni 0.09% Mn — Loss, average	Maximum penetration, average	(2) 17.2% Cr 8.05% Ni 0.41% Mn — Loss, average	Maximum penetration, average	(5) 18.09% Cr 9.18% Ni 0.36% Mn — Loss, average	Maximum penetration, average	(5) 22.08% Cr 12.01% Ni 1.50% Mn — Loss, average	Maximum penetration, average
	I		V		S		T		K[b]		W		Y	
	oz/ft²	Mils	oz/ft²	Mils	oz/ft²	Mils	oz/ft²	Mils	oz/ft²	Mils	oz/ft²	Mils	oz/ft²	Mils
51	...	...	...	...	...	...	...	...	0.0010	6	...	...	...	...
55	0.00012	M	0.0011	U	...	...	...	...	...	...	0.00053	P	0.0015	P
56	...	...	...	...	...	...	...	...	[c] 110	[e] 25+(5, 7)	...	...	...	...
58	...	...	...	...	...	...	...	...	.0011	P	...	...	...	...
59	.00081	P	.0010	P	...	...	...	...	.0011	M	.00071	P	.0021	P
60	[d] .0010	[d] P (5, 7)	[f] .15	[f] P (5)	...	...	...	...	.0012	M(5)	.0012	P	.0024	P
61	...	...	...	...	...	...	...	...	.0016	P	...	...	...	...
62	...	...	...	...	...	...	...	...	.0011	M	...	...	...	...
63	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64	3.17	63+(2, 5, 7)	1.12	63+(2, 5, 7)	0.48	63+(2, 5, 7)	0.11	[d] P(2, 7)	[f] .077	[f] 11+	.0026	P	.0002	P
65	0.010	53+(2, 7)	[f] 0.24	[df] 43+(2, 5, 7)	...	...	...	...	.0011	[d] P(2, 7)	.0015	P(2)	.0020	P(2)
66	.50	55+(2, 5, 7)	.70	63+(7)	...	...	...	...	[f] .25	[f] 11+(5, 7)	.00053	M	[f] 12	[f] 11+
67	...	...	...	...	.00006	[d] M(7)	.0013	M	.0015	P	...	...	...	...

[a] The number in parentheses indicates the number of specimens removed from each test site.
[b] Polished surface.
[c] Data for 1 specimen only.
[d] Average loss of weight or pit depth of 1930 removal is greater.
[e] The number in parentheses after the pit depth indicates that at least 1 specimen of a previous removal was punctured, e.g., (2) indicates a puncture after 2 years.
[f] Data for the individual specimens differed from each other by more than 50 percent.

TABLE B.3-7 -- CORROSION OF 18-8 STEEL (TYPE 304) IN VARIOUS MEDIA

(Air-cooled from 1050° C [1920° F])

Corrosive Medium	Temperature	Duration of Test, hours	Wt. Loss	
			mdd	ipy
20% Nitric acid	Room	1	Nil*	.....
20% Nitric acid	Boiling	18	Nil	.....
3% Nitric acid	Boiling	18	Nil	.....
1% Nitric acid	Boiling	18	Nil	.....
Nitric acid fumes	110° C (230° F)	13	100	0.018
10% Hydrochloric acid	Room	1	360	0.065
10% Sulfuric acid	Room	1	432	0.079
1% H_2SO_4 + 2% HNO_3	Room	17	Nil	.....
0.25% H_2SO_4 + 0.25% HNO_3	Room	17	Nil	.....
10% Acetic acid, C. P.	Room	3	Nil	.....
10% Acetic acid, C. P.	Boiling	12	Nil	.....
Glacial acetic acid, U. S. P.	Room	278	0.1	0.000
Glacial acetic acid, U. S. P.	Boiling	107	130	0.024
Crude acetic acid	Boiling	106	375.5	0.068
10% Phosphoric acid, C. P.	Boiling	17	Nil	.....
10% Carbolic acid, C. P.	Boiling	16	Nil	.....
10% Chromic acid (tech.)	Boiling	41	204	0.037
Concentrated sulfurous acid	Room	22	Nil	.....
0.5% Lactic acid	Boiling	16	4.1	0.001
1.0% Lactic acid	65° C (150° F)	16	Nil	.....
2.0% Lactic acid	Boiling	16	5.1	0.001
50% Lactic acid	Boiling	16	12,240	2.23
85% Lactic acid	Boiling	16	1,560	0.284
10% Tartaric acid	Boiling	39	Nil	.....
1% Oxalic acid	Boiling	39	177.6	0.032
10% Oxalic acid	Room	17	139.2	0.025
10% Formic acid	Boiling	1	3,240	0.590
10% Formic acid	Room	17	2.4	0.000
10% Malic acid	Room	17	Nil	.....
10% Sodium sulfite	Boiling	16	Nil	.....
10% Sodium bisulfate	Boiling	16	Nil	.....
10% Ammonium sulfate	Boiling	16	Nil	.....
10% Ammonium chloride	Boiling	16	Pitted	.....
Lemon juice	Room	89	Nil	.....
Orange juice	Room	91	Nil	.....
Sweet cider	Room	23	Nil	.....
Canned rhubarb	Boiling	16	Nil	.....
Canned tomatoes	Boiling	16	Nil	.....
10% Sodium hydroxide	Boiling	41	Nil	.....

Gas	Temp.		18-8, Type 304	Cb 18-8, Type 347	Mo 18-8, Type 316	Ti 18-8, Type 321	25-12, Type 309	25-20, Type 310
	°C	°F	Inch Penetration per Year					
Cl_2, moist	20	70	0.12–0.42	0.12–0.42	0.04–0.12	0.12–0.42	0.12–0.42	0.12–0.42
SO_2, moist	20	70	<0.04	<0.04	<0.004	<0.04	<0.004	<0.004
SO_2, dry	300	575	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
NH_3, dry	20	70	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
HCl, dry	20	70	Attacked	Attacked	Attacked	Attacked	Attacked	Attacked
HCl, moist	20	70	Badly attacked	Badly attacked	Badly attacked	Badly attacked	Badly attacked	Badly attacked
HF, dry			Attacked	Attacked	Attacked	Attacked	Attacked	Attacked

TABLE B.3-8

TRU CONTENT OF HYDROFRACTURE INJECTIONS

Injection No.	CM-244 (μCi/kg)	Pu-239 (μCi/kg)	Total TRU (μCi/kg)	Additional Dilution Factor Req'd Including CM-244	Credit for CM-244 decay
ILW 7	24	2	26	2.6	1.3
ILW 10	36	.5	36.5	3.7	1.9
ILW 11	228	-	228	22.8	11.4
ILW 13	26	-	26	2.6	1.3
Pilot Plant Wastes(2)	3278	-	3278	328	164
Annual Sludge(2)	787	21	808	81	40.5
Annual Evaporator Bottoms(2)	131	1	132	13	6.5
Gunite Tk Sludge(2)	1049	26	1075	108	54

Notes:

1. Credit has been already taken for dilution factor of 1.4 gained by mixing waste with cement prior to hydrofracture.

2. None of these wastes have yet been injected on a routine basis.

TABLE B.3-9

SUMMARY OF CONSTRUCTION SCHEDULES AND COSTS
ALTERNATIVE SOLIDIFICATION/DISPOSAL METHODS FOR ILW SLUDGES

Method	Engineering & Construction Schedule	Capital Costs ($\$10^6$)	Solidification and Disposal Costs ($/liter of waste[4])
1. Hydrofracture	1982 Sch'd Completion	5.4[1]	0.27
2. Modify hydrofracture equip. for above ground solidification/storage			
a. Without VR	1 yr.	0.25[2]	3.56
b. With VR	3 yr.	5.0[2]	0.26
3. Mobile solidification equip. for above ground solidification/storage			
a. Without VR	1 yr.	0.76	1.30
b. With VR[3]	3 yr.	5.76	0.16

Notes:

1. This cost does not include the expense of moving the solidification equipment to a new location after the capacity of the existing well for accepting grout is exceeded.
2. These costs are over and above the initial $5.4 million for constructing the hydrofracture facility.
3. Unlike the solidification equipment, the VR equipment would not be portable.
4. Solidification/disposal costs are all computed on basis of dilute waste (1 M).

TABLE B.3-10

COMPARISON OF ACTIVITY LEVELS IN WASTE GENERATED AT DOE SITES AND COMMERCIAL REPROCESSING FACILITIES

Source	Specific Activity (Ci/m^3)
DOE[1]	
Liquid HLW[2]	0.17×10^4
Solid HLW (calcined)	3.5×10^4
Commercial[1]	
Liquid HLW[2]	1.35×10^4
Spent Fuel	170.0×10^4
ORNL ILW[3,4]	
Evaporator Concentrate	0.03×10^4
Gunite Tank Sludge (prior to dilution)	0.07×10^4
Pilot Plant	0.26×10^4

Notes:

1. Figures for DOE and commercial waste quantities taken from Roy, 1979.
2. Liquid HLW activity concentrations are based on estimated quantities of Sr-90 and Cs-137 contained in waste.
3. Figures for ORNL waste quantities taken from Liverman, 1977.
4. For direct comparison with waste from other sources, only the Sr-90 and CS-137 are considered in ORNL's waste.

TABLE B.3-11 CHECKLIST FOR REVIEW, APPROVAL, DISTRIBUTION, AND FILING OF ENGINEERING DOCUMENTS

LEGEND:
REVIEW: R
APPROVAL (SIGNATURE): A
DISTRIBUTION: D
FILE: F

		ENGINEERING LINE					ENGINEERING PROJECT TEAM										EXTERNAL					FILE CENTER		
	DOCUMENT TITLE	Director of Engineering	Engineering Site Manager	Division/Discipline Management	Department Supervision	Section Head	Project Manager	Project Engineer	Principal Engineer	Responsible Engineering Designer (RED)	Resource Planning & Control	Estimating Engineer	Procurement Coordinator	Construction Engineer	Contract Coordinator	QA Engineer	Plant Superintendent or Laboratory Director	UCC-ND President and/or V. President	Plant Division Representative (Customer)	Other UCC-ND	Special External Reviews (EP-C-17)	Engineering Services	Plant (Lab) Records	REFERENCE
1.	A-E Design Drawings & Specs				R	R	AD	RD	RD	RD		RD		RD					RD	D	D	F		EP-C-28
2.	Bills of Material				A	A		RD	D	D		D	RD						RD			F		EP-C-21
3.	Conceptual Design Report (CDR)	D	RD	RD	R	RD	AD	RD	RD	R	RD	RD		RD	RD	RD	D		D	D	R		F	EP-C-06
4.	Conceptual Engineering Job Plan		D	D		D	AD	AD	AD	D	RD	RD	RD	RD		D			D	D				EP-B-25
5.	Construction Contract Bid Package							RD	RD	D		D	RD	RD	RD				D					
6.	Construction Specifications				A			AD	AD	RD		RD		RD	RD				D					
7.	Cost Incurrence/Projections						AD	AD	D		RD	R												EP-B-33
8.	Design Criteria Document	D	D	RD	AD	R	AD	AD	AD	RD	RD	D		D	D	RD			D	D			F	EP-C-07
9.	Design Document Systems Reports				RD	R		RD	RD	RD	RD													EP-B-01
10.	Design Drawings				A	A	AD	RD	RD	D		D	D	D	RD	D			AD			F		EP-C-03
11	Deviation Request				D		AD	AD	AD	D	RD	RD		D		RD			D					EP-D-09
12	Engineering Job Plan		D	RD	AD	R	D	AD	AD		RD	D		D	D				D					EP-B-02
13	Engineering Manhour Estimate Summary			A	AD	R	D	D	AD	D	RD	D	D	D										EP-B-14
14	Engineering Manhour Estimate Worksheet			A	A	AD		AD	AD	AD	RD													EP-B-14
15	Engineering Manhour Summary & "S" Curve				D		AD	RD	RD	D	RD	RD												EP-C-20
16	Engr. Monthly Project Highlights (EMPH) Rpt	D	AD	D	D		RD	RD	RD		RD					D	D	D	D					EP-B-30
17	Engineering Service Order (ESO)			D	D		A	D	RD		RD	RD							A					EP-B-03
18	Environmental Assessment	D	D	D			AD	RD	AD		RD				D				D	D	A			EP-C-12
19	Equipment Data Sheets.				A	A		AD	D	D		D	D						D					EP-C-23
20	Equipment Specifications				A	A		AD	D	D		D	D						AD	D				EP-C-22
21	LW Reports				D		D	D	D		RD													EP-B-05
22	Field Change Order						D	RD	RD			D		AD					D					EP-D-09
23	WP Master Status Report	D	AD	D	D		D	AD	R		RD	D	D	D	D	D								EP-D-31
24	In Depth Project Review		AD		D		AD	A	AD		RD	RD	D	RD										EP-B-15
25	Manufacturers Data				A	A				AD									D	D		F		EP-C-25
26	Milestone Report with Contingency Analysis				D		D	RD	D		RD	RD												EP-B-09
27	Monthly Progress Report on Con. Jobs						R	R			RD													
28	Personnel Index	D	D	D	AD		AD	RD	D	D	D	D	D	D		D			D					EP-A-11
29	Preliminary Proposal & Request for Directive Authorization	RD	AD	AD	D		RD	RD	RD		RD	RD				R		A	D					EP-B-23
30	Procurement Schedule & Status Report (PSR				D		D	RD	RD		D	D	AD	D										EP-B-12
31	Project Cost, Estimate, & Schedule Summary						RD	AD	RD		RD	RD	D						D					EP-E-32

TABLE B.3-12 TYPICAL COMPUTERIZED EQUIPMENT LIST

EQUIPMENT NUMBER	SPC DESCRIPTION - OF THE SYSTEM # DESCRIPTION - OF THE ITEM SC SEIS DIV	LOCATION LINKAGE INFO STORAGE	IC	ORDER GAIDM CEIDM	VENDOR / SUPPLIER GAI FOLDER SYS-DIAG	S/U	M.R. M.I.	AVAIL ONSITE DATE	NEEDED ONSITE DATE	FLOAT	ISSUED DATE
0-G50A0023	799 LIQUID RADWASTE SYSTEM OU PHOSPHATE TANK N NS	RWE/06-623 145414 30 -	039	 RI-8	 12-110-00 302-733		004007	A 15JUN9	20FEB9		
0-G50A0024	385 LIQUID RADWASTE SYSTEM FLR DRAIN FILTRATE TANK NS NS N	RWB/02-646 145504 30 -	039	P1093 RH-2	HYDROMATION 12-009-00 302-730		003963 006167	A 24MAR8	15JUN9		26AUG9
0-G50A0025	385 LIQUID RADWASTE SYSTEM FLR DRAIN FILTRATE TANK NS NS N	RWC/02-646 145504 30 -	039	P1093 RH-2	HYDROMATION 12-010-00 302-730		003963 006167	A 24MAR8	15JUN9		26AUG9
0-G50A0026	385 LIQUID RADWASTE SYSTEM WASTE COLL FILTER AIR RECEIVER TANK NS NS N	RWB/03-646 145504 30 -	039	P1093 RH-2	HYDROMATION 12-114-00 302-730		003963	A 24MAR8	15JUN9		
0-G50A0027	385 LIQUID RADWASTE SYSTEM FLR DRNS FILTER AIR RECEIVER TANK NS NS N	RWB/02-646 145504 30 -	039	P1093 RH-2	HYDROMATION 12-115-00 302-730		003963	A 24MAR8	15JUN9		
1-G50A0010	321 LIQUID RADWASTE SYSTEM CNDS FILTER BACKWASH RECEIV TANK NS NS N	TPA/04-548 265101 30 -	042	P1163 MB-2	BISHOPRIC 31-036-00 302-736	1G50E	001160 000843	A 23DEC6	04MAY7		10MAR7
2-G50A0010	321 LIQUID RADWASTE SYSTEM CNDS FILTER BACKWASH RECEIV TANK NS NS N	TPC/04-548 275101 30 -	042	P1163 MB-2	BISHOPRIC 31-036-00 352-737	2G50C	001160 000843	A 25MAR7	02AUG8		10MAR7
0-G50B0001A	445 LIQUID RADWASTE SYSTEM WASTE EVAP/COND - EVAPORATOR SECTION NS NS N	RWB/05-623 145414 30 -	039	P1188 RH-3	WESTINGHOUSE - - 302-742		007044	A 02FEB9	20FEB9		
0-G50B0001B	445 LIQUID RADWASTE SYSTEM WASTE EVAP/COND - EVAPORATOR SECTION NS NS N	RWB/06-623 145414 30 -	039	P1188 RH-3	WESTINGHOUSE - - 302-742		007044	A 02FEB9	20FEB9		
0-G50B0002A	445 LIQUID RADWASTE SYSTEM WASTE EVAP/COND - CONDENSER SECTION NS NS N	RWB/05-623 145414 30 -	039	P1188 RH-3	WESTINGHOUSE - - 302-742		007044	A 02FEB9	20FEB9		
0-G50B0002B	445 LIQUID RADWASTE SYSTEM WASTE EVAP/COND - CONDENSER SECTION NS NS N	RWB/06-623 145414 30 -	039	P1188 RH-3	WESTINGHOUSE - - 302-742		007044	A 02FEB9	20FEB9		
0-G50B0003	790 LIQUID RADWASTE SYSTEM 42 HOT WATER HEATER NS NS N	RWA/07-602 145311 30 -	039	 RH-25	 - - 302-733				18JUL9		
0-G50C0001A	314 LIQUID RADWASTE SYSTEM WASTE COLLECTOR TRANSFER PUMP NS NS N	RWB/09-574 145102 30 -	039	P1235 RH-13	AURORA PUMP 12-029-03 302-731		005058 003274	A 11JUL8	23DEC8		31JUL8
0-G50C0001B	314 LIQUID RADWASTE SYSTEM WASTE COLLECTOR TRANSFER PUMP NS NS N	RWB/10-574 145102 30 -	039	P1235 RH-13	AURORA PUMP 12-029-03 302-731		005058 003274	A 11JUL8	23DEC8		31JUL8
0-G50C0002A	314 LIQUID RADWASTE SYSTEM WASTE SAMPLE PUMP NS NS N	RWB/04-574 145102 30 -	039	P1235 RH-14	AURORA PUMP 12-030-03 302-732		005406 003677	A 16AUG8	23DEC8		19SEP8

TABLE B.3-13

VOLUME REDUCTION STUDY MATRIX

	DESCRIPTION OF VOLUME REDUCTION TECHNIQUES	DRY COMBUSTIBLE	DRY COMPACTIBLE	FERROUS METALS	NON-FERROUS METALS	GLASSWARE	AQUEOUS LIQUIDS	SLURRY WASTES (RESINS, FILTER BACKWASH, ETC.)
1.	Incineration (all types)	X						
2.	Slagging Pyrolysis	X		X	X	X		
3.	Calcination						X	X
4.	Acid Digest-ion	X						X
5.	Biological Decomposition	X						X
6.	Evaporation (all types)						X	
7.	Compaction		X					
8.	Cutting (grinding, shredding, etc.)			X	X	X		
9.	Melting			X	X	X		
10.	Decontamination & Reuse			X	X			
11.	Administrative Controls (all types)	X	X	X	X	X	X	X

TABLE B.3-14

DEFINITIONS OF WASTE CATEGORIES

PROPOSED IN DRAFT 10 CFR 61

CLASS A - Generic minimal packaging and disposal requirements

CLASS B - Generic minimal packaging and disposal requirements plus special stability requirements

CLASS C - General minimal packaging and disposal requirements plus special stability requirements plus special burial requirements

TABLE B.3-15

ACTIVITY LIMITATIONS (μCi/cc) FOR WASTE CATEGORIES

PROPOSED IN DRAFT 10CFR61

ISOTOPE	CLASS A	CLASS B	CLASS C	DOT LSA[4]	DOT LSS[4]	DOT TYPE A (IN 55 GAL DRUMS)[4]	DOT LSA[5]
$T_{1/2}$ < 5 YR	$7x10^{2}$	$7x10^{4}$	Note 2	-	-	-	-
H-3	$4x10^{1}$	$1x10^{8}$	Notes 2 & 3	$1x10^{5}$	$2x10^{6}$	$5x10^{3}$	$3x10^{2}$
C-14	$8x10^{1}$	$8x10^{1}$	$8x10^{-1}$ (Note 3)	$1x10^{4}$	$2x10^{5}$	$5x10^{2}$	$3x10^{2}$
NI-59	2.2	2.2	2.2	$9x10^{4}$	$1.8x10^{6}$	$4.5x10^{3}$	$3x10^{2}$
CO-60	$7x10^{2}$	$7x10^{4}$	Note 2	$7x10^{2}$	$1.4x10^{4}$	$3x10^{1}$	$3x10^{2}$
NI-63	3.5	$7x10^{1}$	$7x10^{1}$	$1x10^{4}$	$2x10^{5}$	$5x10^{2}$	$3x10^{2}$
NB-94	$2x10^{-3}$	$2x10^{-3}$	$2x10^{-3}$	$2x10^{3}$	$2x10^{4}$	$1x10^{2}$	$3x10^{2}$
SR-90	$4x10^{-2}$	$1.5x10^{2}$	$7x10^{2}$	$4x10^{1}$	$8x10^{2}$	2.0	5
TC-99	$3x10^{-1}$	$3x10^{-1}$	$3x10^{-1}$ (Note 3)	$8.2x10^{3}$	$1.6x10^{5}$	$4.1x10^{2}$	$3x10^{2}$
I-129	$8x10^{-3}$	$8x10^{-3}$	$8x10^{-3}$ (Note 3)	$2x10^{2}$	$4x10^{3}$	$1x10^{1}$	$3x10^{2}$
CS-135	$8.2x10^{1}$	$8.4x10^{1}$	$8.4x10^{1}$	$1x10^{4}$	$2x10^{5}$	$5x10^{2}$	$3x10^{2}$
CS-137	1.0	$4.4x10^{1}$	$4.6x10^{3}$	$2x10^{3}$	$4x10^{4}$	$1x10^{2}$	$3x10^{2}$
ENRICHED U-238	$4x10^{-2}$	$4x10^{-2}$	$4x10^{-2}$	$1x10^{1}$	$2x10^{2}$	$5x10^{-1}$	$3x10^{2}$
NAT. OR DEPELETED U-238	$5x10^{-2}$	$5x10^{-2}$	$5x10^{-2}$	UNLIMITED	UNLIMITED	UNLIMITED	$3x10^{2}$
EMITTING TRU	-	-	$1x10^{-8}$	-	-	-	$1x10^{-1}$
PN-241	-	-	$3.5x10^{-7}$	$1x10^{1}$	$2x10^{2}$	$5x10^{-1}$	$1x10^{-1}$

NOTES:

1 - $\sum_{i=1}^{n} a_i/A_i$ for each waste category.

2 - Theoretical max specific activity - site different (see note 3).

3 - Each site will have specified limit on total quantity of activity buried over the life of the facility. These will be used to determine this limit.

4 - These limits based on proposed Table 127.305 of 10CFR49.

5 - These limits based on paragraph 173.389 of 10CFR49.

TABLE B.3-16

PACKAGING REQUIREMENTS FOR WASTE CATEGORIES

PROPOSED IN DRAFT 10CFR61

	REQUIREMENT	APPLICABLE WASTE CATEGORY A	B	C
1.	10 CFR Part 71 packaging requirements	X	X	X
2.	49 CFR Part 171-179 packaging requirements	X	X	X
3.	Segregation by activity concentration	X	X	X
4.	Cardboard or fiberboard boxes excluded	X	X	X
5.	Liquids packaged with absorbent twice the volume of liquid	X	X	X
6.	No readily explosive material	X	X	X
7.	No significant volume of toxic gases	X	X	X
8.	No pyrophoric material	X	X	X
9.	Shred gaseous waste must be at atmospheric pressure	X	X	X
10.	Pretreat biological pathogenic or infectious material to reduce hazard	X	X	X
11.	Less than 1% free water, non-corrosive	X	X	X
12.	Maintain physical form under 50 psig		X	X
13.	Minimize void spaces		X	X

TABLE B.3-17

BURIAL REQUIREMENTS FOR WASTE CATEGORIES

PROPOSED IN DRAFT 10CFR61

	REQUIREMENT	APPLICABLE WASTE CATEGORY		
		A	B	C
1.	Segregate in separate disposal units	X		
2.	Orderly emplacement to maintain package integrity		X	X
3.	Full void spaces between packages after placement		X	X
4.	Limit surface gamma radiation levels to near background		X	X
5.	Permanently mark boundaries and location of trenches		X	X
6.	100 ft buffer zone between trenches and site boundary		X	X
7.	Institute adequate closure and stabilization measures as each disposal unit is closed		X	X
8.	Active disposal operations must not adversely effect closed units		X	X
9.	Waste must be 5 meters below surface or covered by natural or engineered barriers to provide protection against intrusion for 500 years			X

ORNL DWG 81-23579

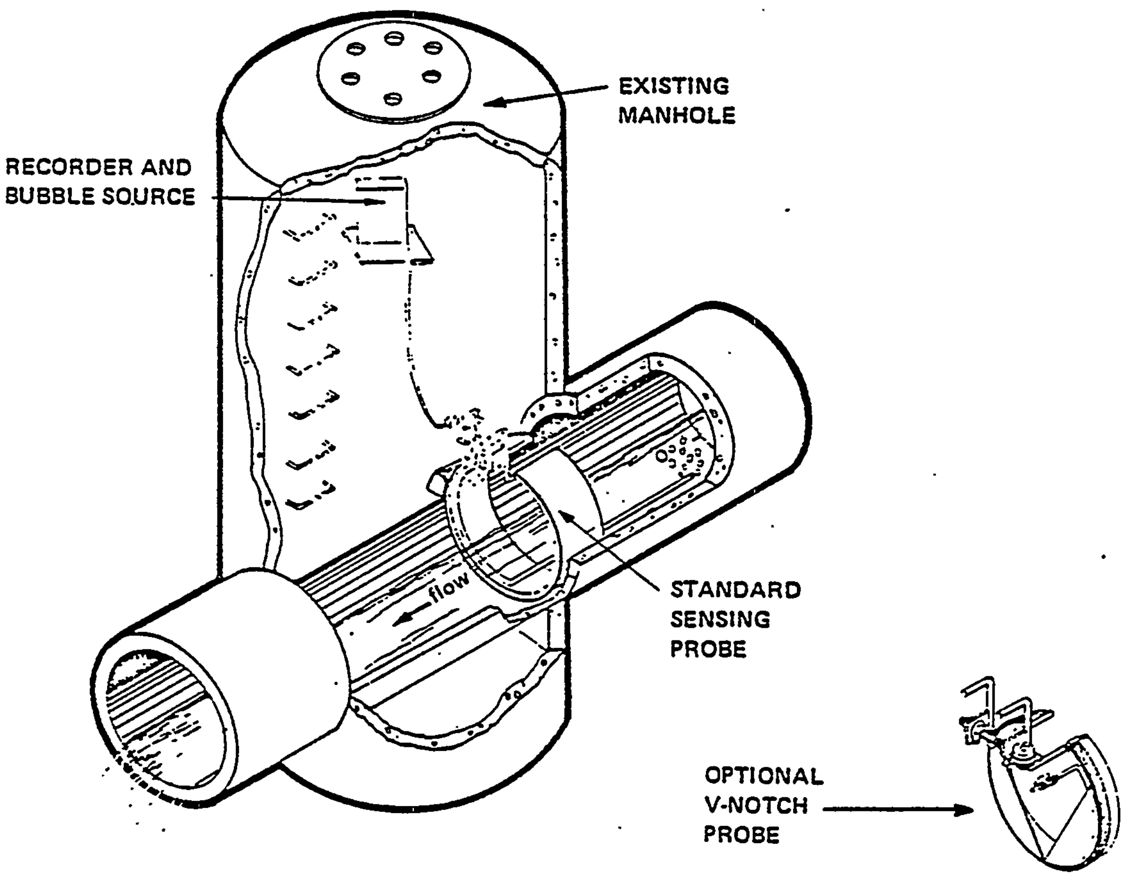


FIGURE B.3-1 PORTABLE SEWER FLOW MONITOR

ORNL DWG 81-23580

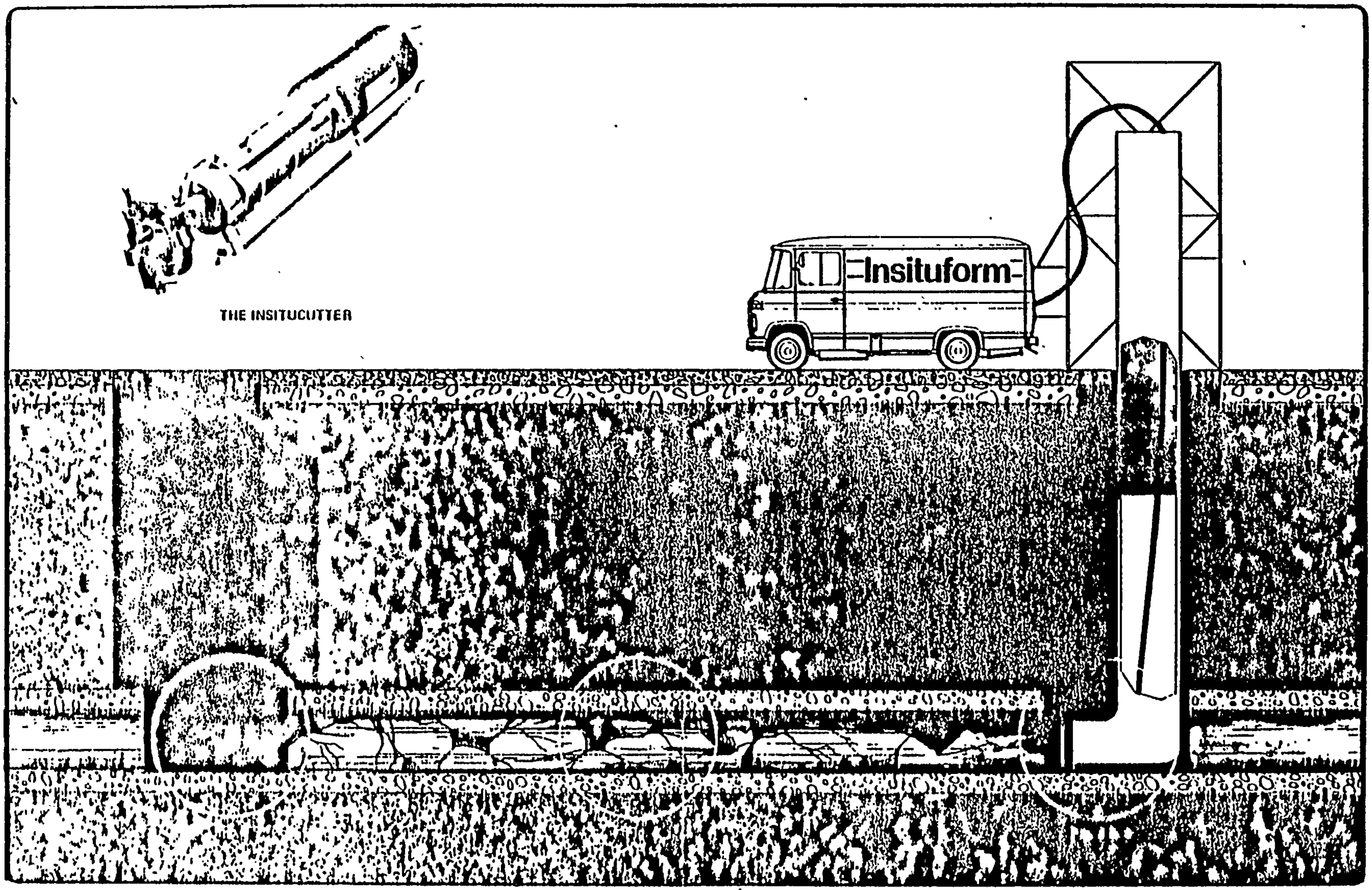


FIGURE B.3-2 TYPICAL METHOD FOR INSTALLATION OF A MEMBRANE LINER IN UNDERGROUND PIPING

ORNL DWG 81-23581

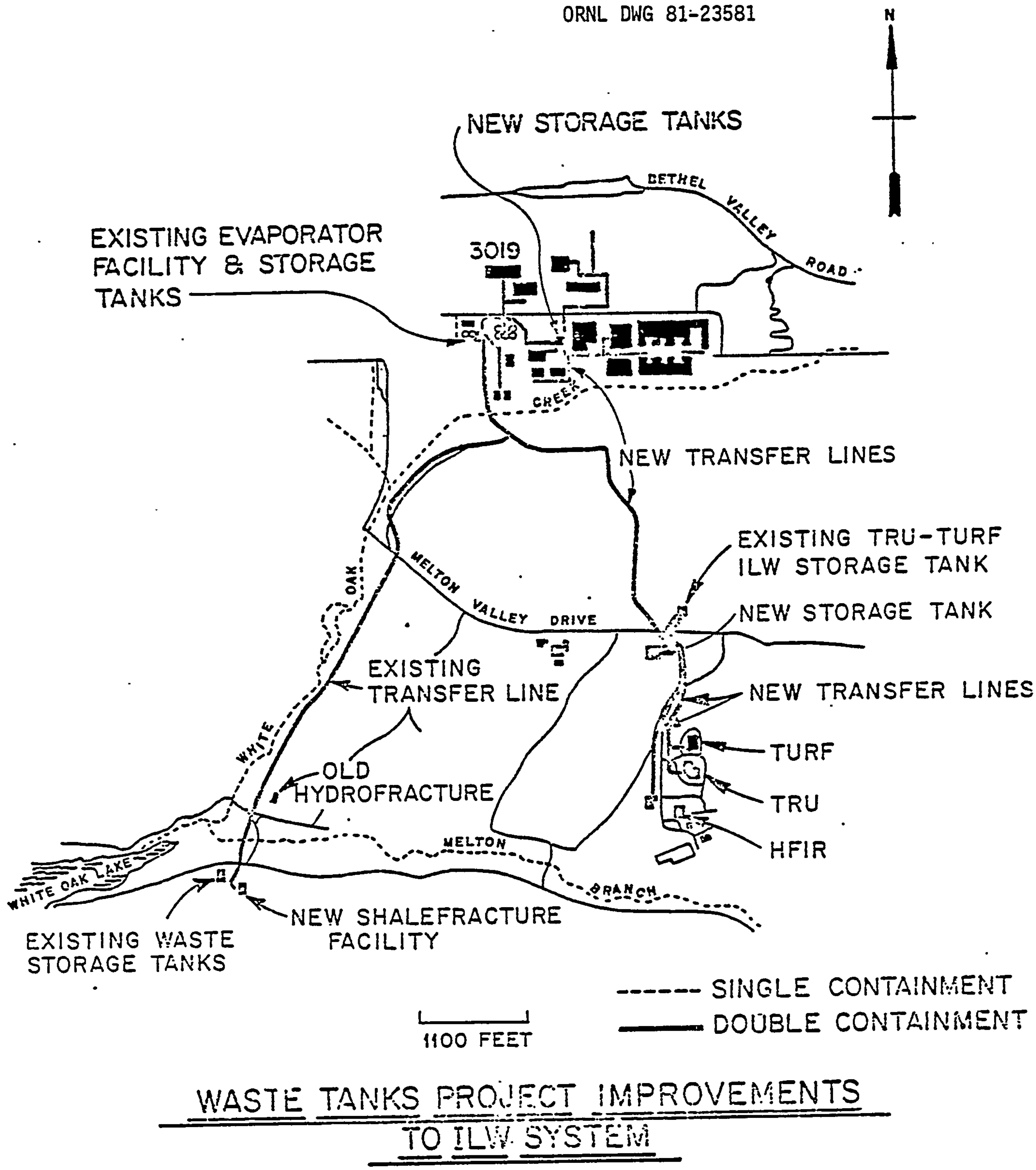


FIGURE B.3-3
PROPOSED CONSOLIDATION OF ILW COLLECTION SYSTEM
IN BETHEL VALLEY

ORNL DWG 81-23582

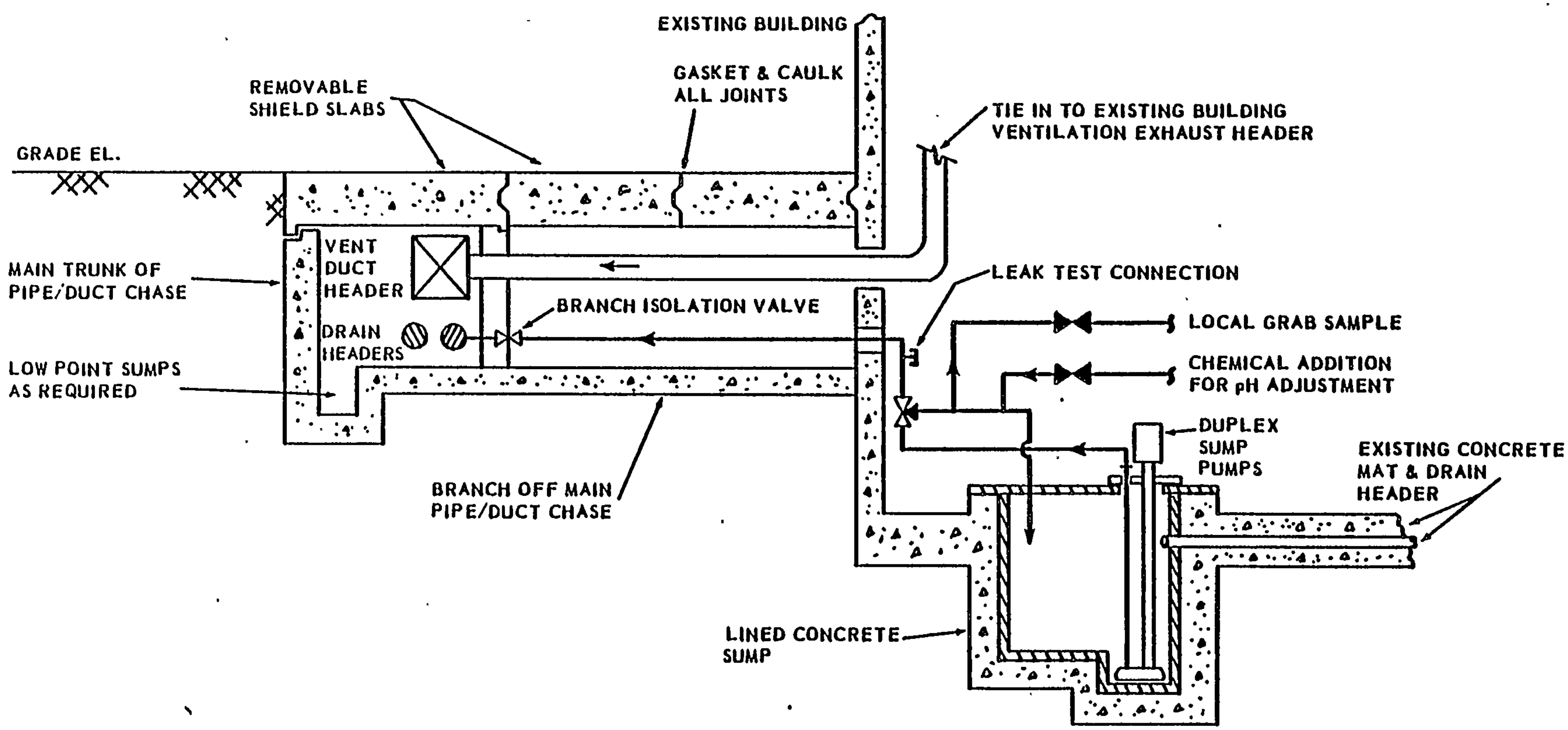


FIGURE B.3-4
CONCEPTUAL ARRANGEMENT FOR CONSOLIDATED APPROACH TO LIQUID LLW/ILW AND GASEOUS RADWASTE COLLECTION

ORNL DWG 81-23583

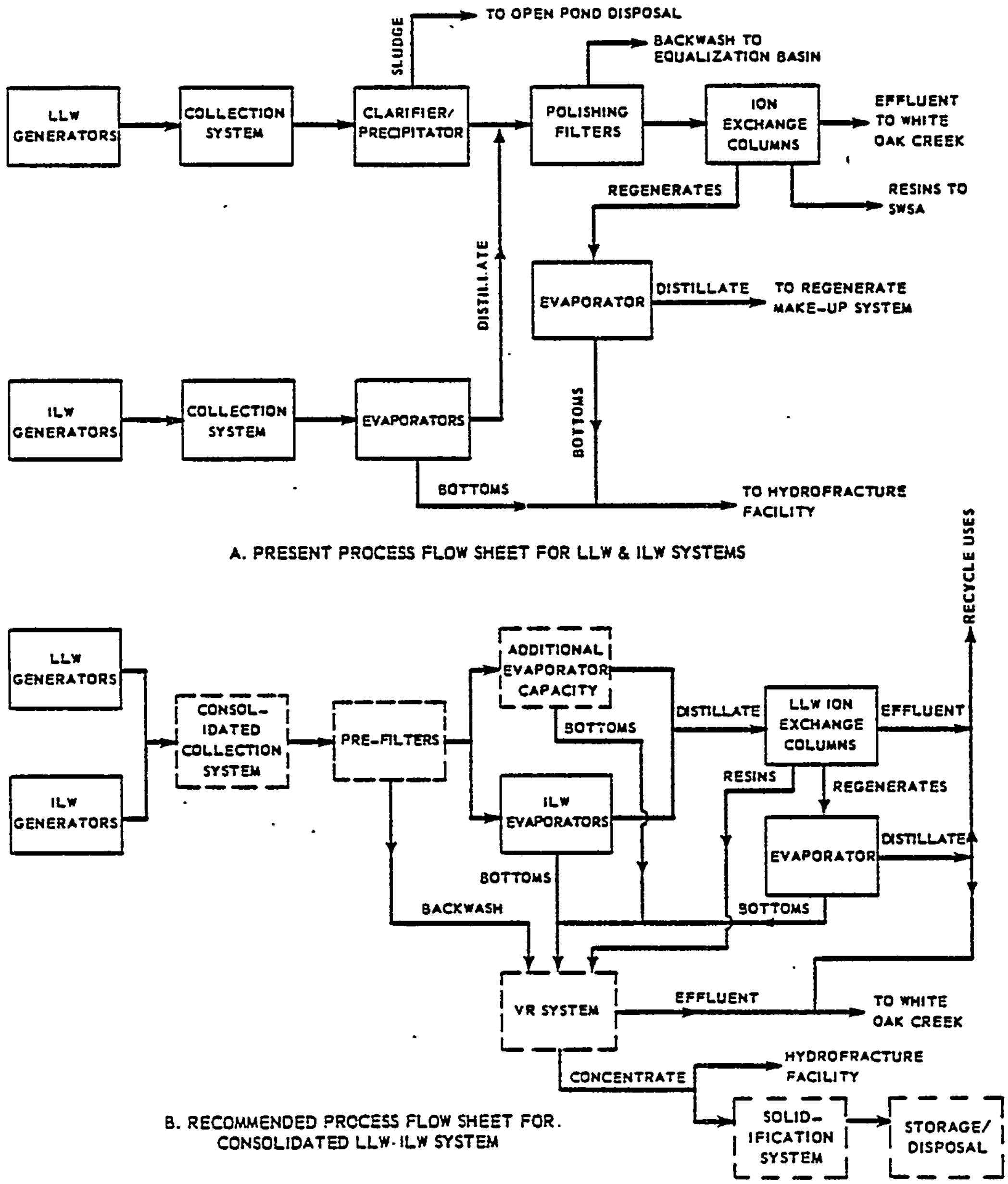


FIGURE B.3-5

PRESENT/FUTURE FLOW SHEETS FOR LLW & ILW SYSTEMS

ORNL DWG 81-23584

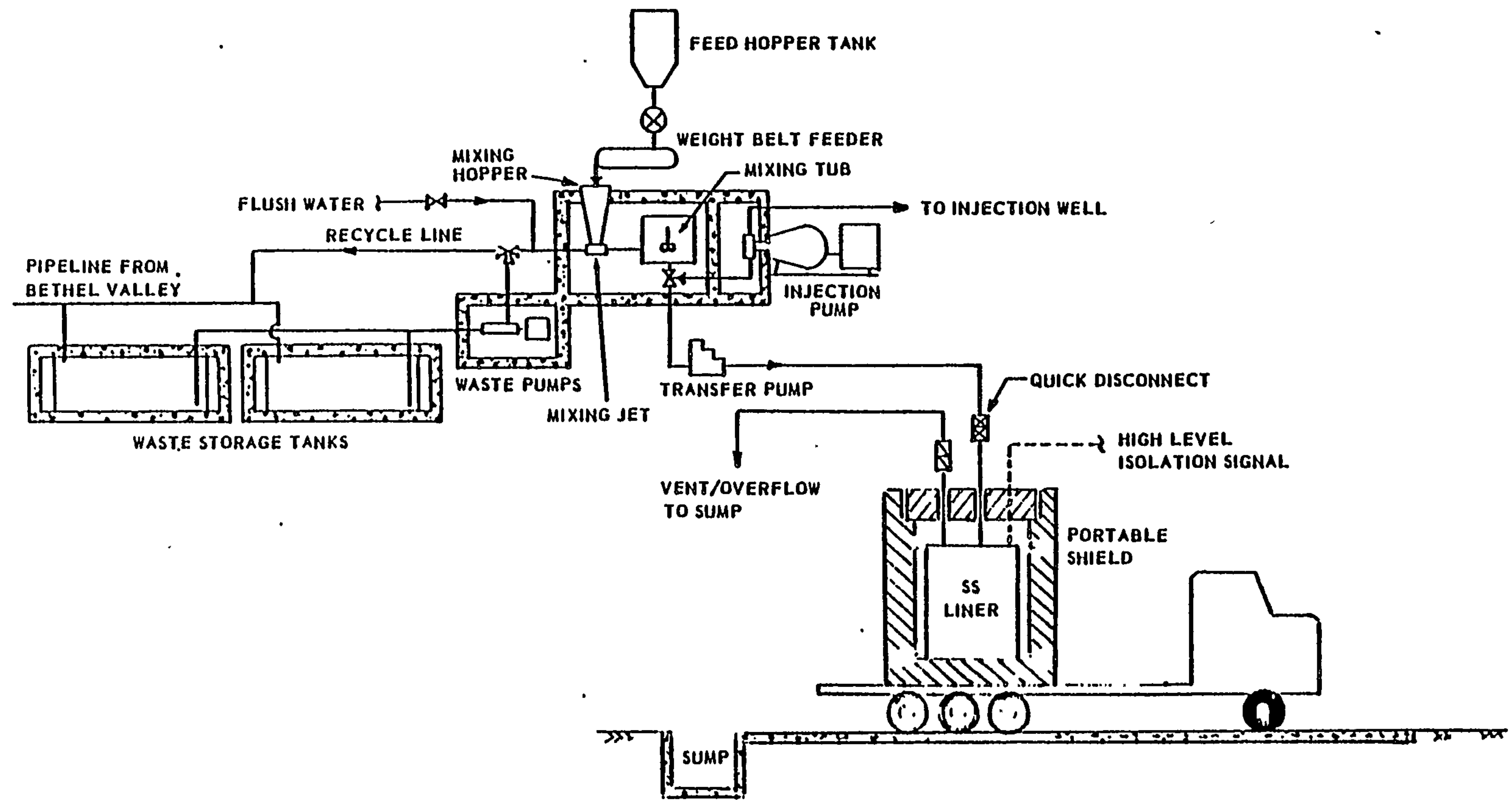


FIGURE B.3-6
MODIFICATIONS TO HYDROFRACTURE FACILITY FOR ABOVEGROUND SOLIDIFICATION & STORAGE OF ILW

ORNL DWG 81-23585

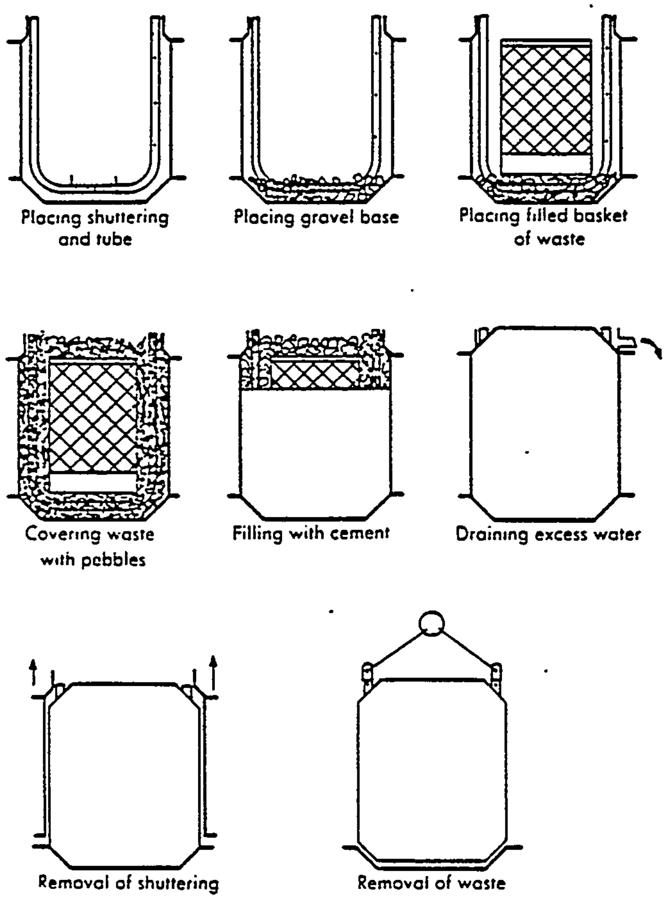
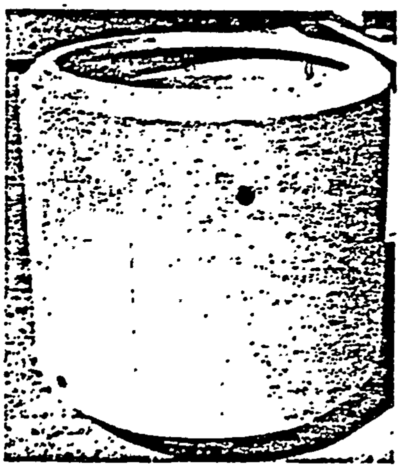
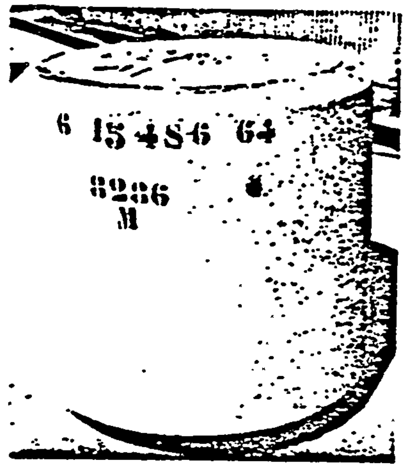


FIGURE B.3-7
SEQUENCE OF STEPS FOR ONE METHOD OF CASTING CONCRETE STORAGE MODULES FOR HIGH ACTIVITY WASTE

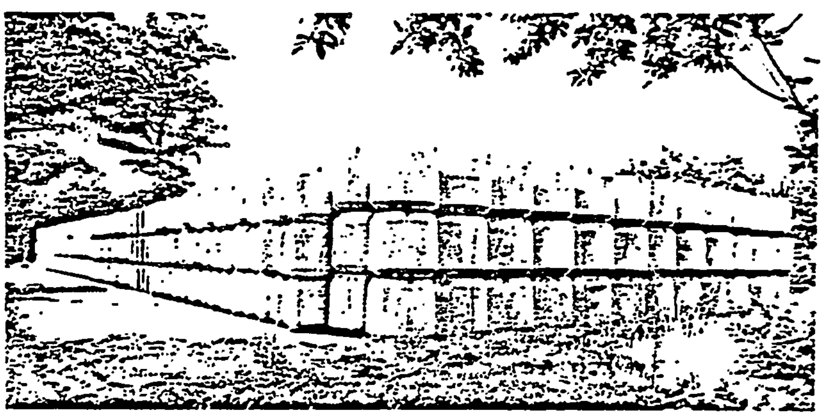
ORNL DWG 81-23586



A. PRECAST CONCRETE CASK
BEFORE FILLING



B. CONCRETE CASK
FILLED AND CAPPED



C. HIGH ACTIVITY WASTE STORED IN THREE-TIERED
CONCRETE CASKS AT SACLAY

FIGURE B.3-8
ABOVEGROUND STORAGE OF HIGH ACTIVITY WASTE
IN STACKABLE CONCRETE CASKS

ORNL DWG 81-23587

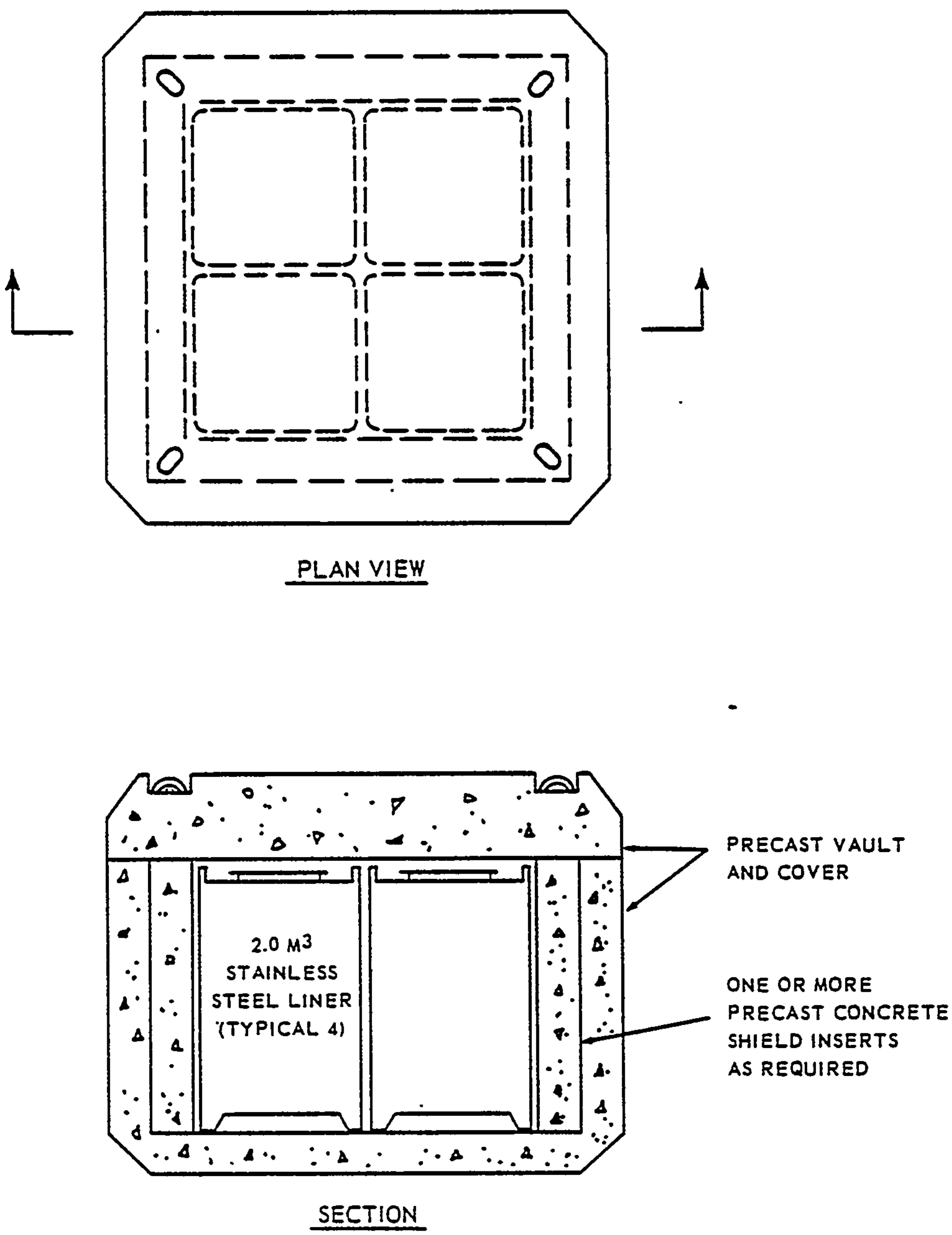
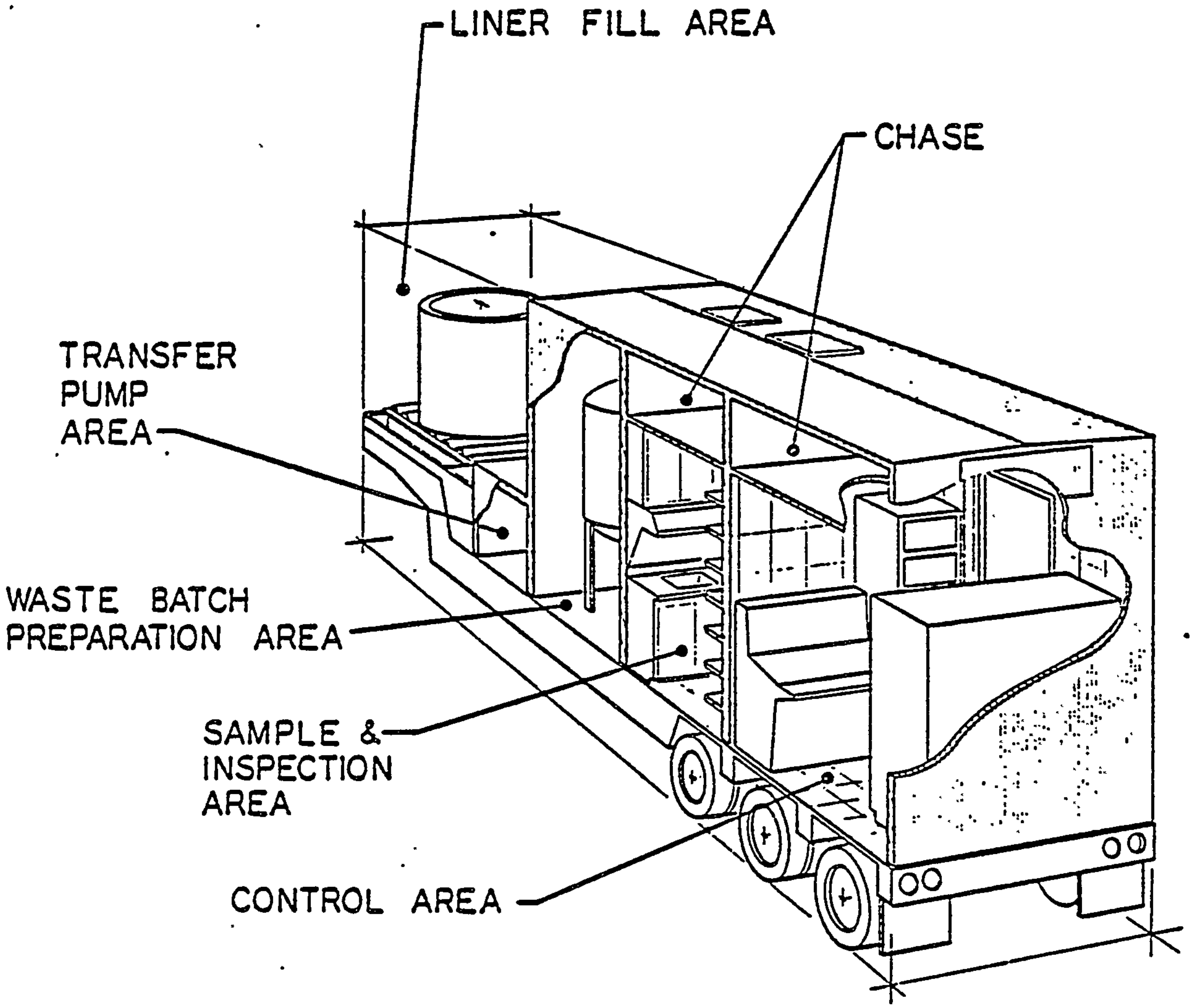


FIGURE B.3-9
ARRANGEMENT OF TYPICAL ABOVEGROUND
STORAGE MODULE CONTAINING FOUR CANISTERS
OF SOLIDIFIED HIGH ACTIVITY WASTE

ORNL DWG 81-23588



Note: Portable shielding required around truck when in operation

FIGURE B.3-10
MOBILE SOLIDIFICATION SYSTEM UTILIZING DOW VINYL ESTER RESIN

ORNL DWG 81-23589

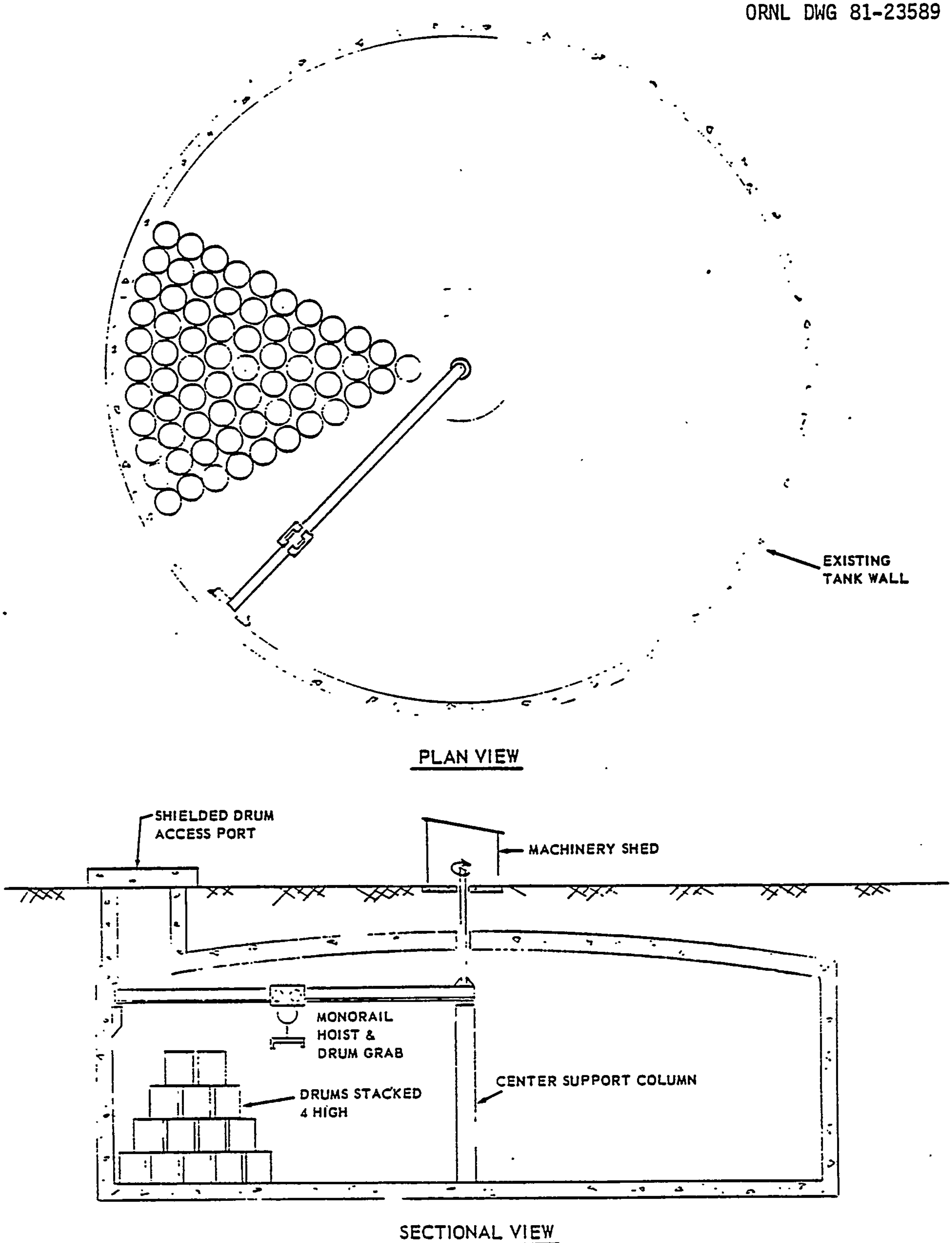


FIGURE B.3-11
CONCEPTUAL ARRANGEMENT FOR SRW DRUM STORAGE
IN EXISTING GUNITE TANK

APPENDIX C

DEFINITIONS AND ACRONYMS

Definitions

1. Alloy 20 - Moderately high nickel/chromium alloy steel similar to Incoloy.

2. Cathodic protection - a method of preventing corrosion of metals by impressing an electrical current onto the surface of the metal to create a potential difference between this surface and a sacrificial, anodic material introduced into the system for this purpose.

3. General SRW - See Appendix A Section No. 1.2.

4. Gunite Tanks - concrete tanks fabricated by a process in which concrete is sprayed onto reinforcing.

5. High Level Waste - See Appendix A Section No. 1.3.

6. Hydrofracture - injection of a liquid waste and grout mixture into underground shale formations at high pressures, causing horizontal fracturing of the shale and the creation of stable grout/waste sheets between layers of shale.

7. Incoloy - Moderately high nickel/chromium alloy steel developed by Huntington Alloys, Inc.

8. Inconel - High nickel/chromium alloy steel developed by Huntington Alloys, Inc.

9. Intermediate Level Waste - See Appendix A Section No. 1.3.

10. Isokinetic - A condition which prevails when the velocity of air entering a sampling probe or the collector when held in the airstream is identical to the velocity of the airstream being samples at that point.

11. Low Level Waste - See Appendix A Section No. 1.3.

12. Non TRU Waste - See Appendix A Section No. 1.5.

13. TRU Waste - Transurance Waste - See Appendix A Section No. 1.2.

14. 304L/316L - Special grades of very low carbon stainless steels.

Acronyms

1. AEC - Atomic Energy Commission
2. ALAP - As Low as Possible
3. BWR - Boiling Water Reactor
4. CEGB - Central Electric Generating Board
5. D & D - Decontamination and Decommissioning
6. DAS - Data Acquisition System
7. DOE - Department of Energy
8. EPA - Environmental Protection Agency
9. FEIS - Final Environmental Impact Statement
10. FSAR - Final Safety Analysis Report
11. GM - Geiger-Mueller
12. GRW - Gaseous Radwaste
13. HEPA - High Efficiency Particulate Filters
14. HFIR - High Flux Isotope Reactor
15. HLW - High-Level Transuranic Waste
16. IAD - Intermediate Action Directive

17. ILW - Intermediate-Level Waste

18. K-25 - Oak Ridge Gaseous Diffusion Plant

19. LLW - Low Level Waste

20. LLWDF - Low Level Waste Disposal Facility

21. LRW - Liquid Radioactive Waste

22. MPC - Maximum Permissible Concentration

23. NRC - Nuclear Regulatory Commission

24. NWTS - National Waste Terminal Storage

25. ONWI - Office of Nuclear Waste Isolation

26. ORNL - Oak Ridge National Laboratory

27. PCB - Polychlorinates Biphenyl

28. PGDP - Paducah Gaseous Diffusion Plant

29. P&ID - Piping and Instrumentation Diagram

30. PM - Photomultiplier

31. PVC - Polyvinyl Chloride

32. PWBS - Program Work Breakdown Structure

33. PWR - Pressurized Water Reactor

34. R&D - Research and Development

35. RCRA - Resource Conservation Recovery Act

36. SPIX - Scavenging Precipitation Ion Exchange Column

37. SS - Stainless Steel

38. SRW - Solid Radioactive Waste

39. SWIMS - Solid Waste Inventory Management System

40. SWSA - Solid Waste Storage Area

41. TMI-2 - Three Mile Island - Unit 2

42. TRU - Transuranic

43. TURF - Thorium Uranium Recovery Facility

44. UCC-ND - Union Carbide Corp. - Nuclear Division

45. VR - Volume Reduction

46. WOCC - Waste Operation Control Center

47. X-10 - ORNL Site

APPENDIX C

Bldg. No.	Abbreviation	Description
2523	-	Decontamination Laundry
2531	-	Radioactive Waste Evap. Bldg.
2533	-	Cell Ventilation Filter Pit (for Bldg. 2531)
2534	-	Off-Gas Filter Pit (for Bldg. 2531)
2537	-	Evaporator Service Tank & Control Room (for Bldg. 2531)
2624	SWSA-1	Solid Waste Storage Area No. 1
3001	OGR	Graphite Reactor
3002	-	Filter House
3003	-	Solid State Accelerator Facility
3004	-	Water Demineralizer
3005	LITR	Low-Intensity Testing Reactor

APPENDIX C

Bldg. No.	Abbreviation	Description
3008	-	Source and Special Materials Vault
3010	-	Bulk Shielding Reactor Facility
3018	-	Exhaust Stack (for Bldg. 3303)
3019-A	-	Radiochemical Processing Pilot Plant
3019-B	-	High-Level-Radiation Analytical Laboratory (A)
3020	-	Exhaust Stack (for Bldg. 3019)
3021	-	Turbine House (for Bldg. 3019)
3023	-	North Tank Farm
3025-E	-	Physical Exam. Hot Cells-A
3025-M	-	Solid State Division Laboratories

APPENDIX C

Bldg. No.	Abbreviation	Description
3026-C	-	Radioisotope Development Laboratory - B
3026-D	-	Dismantling & Examination Hot Cells
3027	-	SNM Vault
3028	-	Radioisotope Production Laboratory - A
3029	-	Radioisotope Production Laboratory - B
3030	-	Radioisotope Production Laboratory - C
3031	-	Radioisotope Production Laboratory - D
3032	-	Radioisotope Production Laboratory - E
3033	-	Radioisotope Production Laboratory - F
3033-A	-	Radioisotope Production Laboratory Annex

APPENDIX C

Bldg. No.	Abbreviation	Description
3034	-	Radioisotope Area Services
3036	-	Isotope Area Storage and Service Building
3037	-	Operations Division Offices
3038	-	Radioisotope Laboratory
3039	-	Central Radioactive Gas Disposal Facilities
3042	ORR	Oak Ridge Research Reactor
3044	-	Special Materials Machine Shop
3047	-	Isotope Technology Building
3074	-	Interim Manipulator Repair Facility
3077	-	Air Cooler - LITR
3080	-	Reactor Experiment Control Room

APPENDIX C

Bldg. No.	Abbreviation	Description
3083	-	Neutron Spectrometer Station No. 1
3084	-	Neutron Spectrometer Station No. 2
3085	-	Pumphouse - ORR
3086	-	Cooling Tower No. 1 - ORR
3087	-	Heat Exchanger - ORR
3088	-	Bulk Shielding Reactor Stor.
3089	-	Cooling Tower No. 2 - ORR
3091	-	Filters (for Bldg. 3019)
3092	-	Off-Gas Facility-4000 CFM
3093	-	Storage Cubicle for Krypton Cylinders
3095	-	Reactor Area Equipment Bldg.
3098	-	Filter Facility (for LITR & BSR)

APPENDIX C

Bldg. No.	Abbreviation	Description
3100	-	Source and Special Materials Vault
3102	-	Heat Exchanger No. 2 - ORR
3103	-	Cooling Tower No. 3 - ORR
3105	WOCC	Waste Monitoring Control Center
3106	-	Cell Ventilation Filters - 4501, 4505 & 4507
3107	-	25-Meter Target House on Flight Path Extension
3108	-	Cell and Hood Ventilation Filters - 3019
3109	-	Off-Gas Filters for ORR
3110	-	Cell Ventilation Filters (for Radioisotope Area)
3117	-	BSR Cooling Tower
3118	-	Radioisotope Production Laboratory H

APPENDIX C

Bldg. No.	Abbreviation	Description
3119	-	BSR Heat Exchanger and Pumphouse
3121	-	Cell Off-Gas Filter House (for Bldg. 3019)
3126	-	Charcoal Filter (NOG) ORR
3127	-	Plutonium Storage Vault
3503	-	High-Radiation-Level Engineering Laboratory
3505	-	Fission Product Dev't Laboratory Annex
3506	-	Radioisotope Production Laboratory - G
3507	-	South Tank Farm
3508	-	Chemical Technology Alpha Lab
3513	-	Settling Basin
3517	FPDL	Fission Prod. Dev't Lab

APPENDIX C

Bldg. No.	Abbreviation	Description
3518	-	Process Waste Water Treatment Plant
3523	-	Controls Research
3524	-	Process Waste System Basin
3525	-	High-Radiation-Level Examination Laboratory
3539	-	Process Waste Pond No. 1 (North)
3540	-	Process Waste Pond No. 2 (South)
3541	-	MSR Process Dev't Lab
3543	-	MSR Development Laboratory
3544	-	Process Waste Treatment Plant
3584	-	Contaminated Materials Storage
3594	-	Waste Mgmt. Storage Bldg.
3597	-	Hot Storage Garden

APPENDIX C

Bldg. No.	Abbreviation	Description
3601	-	H.E.P.A. Filter House
3604P	-	WC-21 & WC-22 Tank Vault (proposed)
4003	SWSA-2	Solid Waste Storage Area No. 2
4500	-	Central Research & Administration
4501	-	High-Level Radiochem. Lab.
4505	-	Experimental Engineering
4507	-	High-Radiation-Level Chemical Development Laboratory
4556	-	Filter Pit (for Bldg. 4507)
5500	-	High Voltage Accelerator Laboratory
5505	-	Transuranium Research Laboratory
5507	-	Electron Spectrometer Facility

APPENDIX C

Bldg. No.	Abbreviation	Description
6000	HHIRF	Holifield Heavy Ion Research Facility (HHIRF)
6001	-	Cooling Tower (for Bldg. 6000)
6010	ORELA	Electron Linear Accelerator
6025	-	Engineering Physics Office/ Laboratory Building
7018	-	Salvage & Reclamation Facility
7019	-	Hazardous Materials Storage
7020	-	Interim Grounds Equip. Storage
7021	-	Fabrication Equip. Storage
7022	-	Gas Cylinder Storage Shed
7025	-	Tritium Target Facility
7500	-	Nuclear Safety Pilot Plant

APPENDIX C

Bldg. No.	Abbreviation	Description
7502	-	Radioactive Waste Evaporator (for Bldg. 7500)
7503	MSRE	Molten - Salt Reactor Experiment Building
7511	-	Filter Pit (for Bldg. 7503)
7512	-	Stack (for Bldg. 7503)
7513	-	Cooling Tower (for Bldg. 7503)
7514	-	Filter House (for Bldg. 7503)
7554	-	Cooling Tower (for Bldg. 7500)
7557	-	Adsorber Pit (for Bldg. 7500)
7558	-	Waste Evaporator Loading Pit (for Bldg. 7500)
7559	-	Adsorber Valve Pit (for Bldg. 7500)

APPENDIX C

Bldg. No.	Abbreviation	Description
7560	-	Waste Tank (for Bldg. 7500)
7561	-	Valve Pit (for Bldg. 7500)
7562	-	Waste Condensate Tank (for Bldg. 7500)
7563	-	Circulator Pump Pit (for Bldg. 7500)
7567	-	Intermediate Level Waste Pumping Station (west of Bldg. 7503)
7569	-	Melton Valley Collection Tank WC-20
7600	-	Containment Bldg.
7602	-	Engineering-CFRP
7603	-	Experimental Engineering CFRP
7608	-	Component Development CFRP
7609	-	Stack Monitoring House

APPENDIX C

Bldg. No.	Abbreviation	Description
7610	-	Storage House - CFRP
7612	-	Elevated Storage Tank - CFRP
7613	-	Waste Rentention Basin
7614	-	Exhaust Stack for Bldg. 7600 & 7602
7615	-	Material Storage
7700	TSF	Tower Shielding Facility
7701	-	Pool-Tower Shielding Facility
7702	-	Control House Tower Shielding Facility
7703	-	Hoist House Tower Shielding Facility
7704	-	Control House No. 2 Tower Shielding Facility
7705	-	Pump House Tower Shielding Facility

APPENDIX C

Bldg. No.	Abbreviation	Description
7706	-	Cooler-Tower Shielding Facility
7708	-	Reactor Shield Storage - Tower Shielding Facility
7709	HPPR	Health Physics Res. Reactor
7710	-	Dosar Facility - HPRR
7711	-	Process Waste Basin for Bldg. 7709
7712	-	Dosar Low Energy Accelerator
7716	-	Filter Pump House Main. Pool
7717	-	TSF Experiments Bldg.
7755	-	Reservoir - HPRR
7756	-	Meter House - HPRR
7758	-	Storage for Bldg. 7709
7800	SWSA-4	Solid Waste Storage Area No. 4

APPENDIX C

Bldg. No.	Abbreviation	Description
7802	SWSA-5	Solid Waste Storage Area No. 5
7804	-	Storage
7805	-	Waste Pit No. 1 (Abandoned)
7806	-	Waste Pit No. 2 (Abandoned)
7807	-	Waste Pit No. 3 (Abondoned)
7808	-	Waste Pit No. 4
7809	-	Waste Trench No. 5
7810	-	Chemical Waste Trench No 6 (Abandoned)
7811	-	Pilot Pits 1 and 2
7812	-	White Oak Dam Control Bldg.
7813	-	White Oak Creek Dam
7816	-	Waste Research Storage

APPENDIX C

Bldg. No.	Abbreviation	Description
7818	-	Waste Trench No. 7
7819	-	Interim Decontamination Bldg.
7821	-	Emergency Waste Basin (Melton Valley)
7822	SWSA-6	Solid Waste Storage Area No. 6
7823	-	Underground Storage Bldg. (for 7802)
7824	-	Radioactive Waste Storage Bldg. (for 7802)
7825	-	ILW Interim Storage Tank Facility
7826	-	Retrievable Waste Storage Facility
7827	-	High Level Alpha Waste Storage
7829	-	Peach Bottom Storage Wells

APPENDIX C

Bldg. No.	Abbreviation	Description
7830	-	Waste Storage Tanks & Control Room
7831	-	Solid Waste Compactor Facility
7833		Alpha Greenhouse Facility
7834	-	Retrievable Waste Storage Facility No. 2
7835	-	Sludge Waste Pond (for Bldg. 3544)
7841	-	Contaminated Equipment Storage Area
7852	-	Shale Fracturing Batch Plant
7855	-	Storage Facility for HRL Retrievable Waste
7860	-	Hydrofracturing Facility
7900	-	HFIR
7902	-	Cooling Tower (for Bldg. 7900)

APPENDIX C

Bldg. No.	Abbreviation	Description
7903	-	Cooling Tower Equip. Bldg. (for Bldg. 7900)
7905	-	Retention Pond No. 1 (HFIR)
7906	-	Retention Pond No. 2 (HFIR)
7907	-	Retention Pond No. 3 (for TPP)
7908	-	Retention Pond No. 4 (for TPP)
7911	-	Stack (for Bldg. 7900)
7912	-	Fan Shed (for 7911 Stack)
7913	-	Filter Pit (for 7911 Stack)
7920	TRU	Transuranium Processing Plant
7922	-	Breeching and Fan Area (for Bldg. 7920)
7930	TURF	Thorium-Urnaium Recycle Facility

APPENDIX C

Bldg. No.	Abbreviation	Description
7932	-	Waste Sample Bldg. (for Bldg. 7930)
7952	-	Low Level Waste Pumping Station (near HFIR Pond)
9204-3	-	Isotope Separations
9213	-	Criticality Lab
9409-15	-	Cooling Tower for 9204-3 (Isotope Separation)
9409-16	-	Cooling Tower for 9204-3 (Isotope Separation)
9732-2	-	86-inch Cyclotron Counting Room
9770-2	-	Radiation Source

APPENDIX D

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REFERENCES

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